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## THE PRODUCTS OF PRIMARY BATTERIES.

IN the greater number, if not in all, the schemes brought forward of late years for utilising primary batteries on a commercial scale, the tempting bait to investors has been the production of electricity for nothing, and the certainty of handsome dividends from the bye products of the spent solutions; but it has been reserved for M. Perreur-Lloyd to reverse the nature of things. In his marvellous invention the battery is employed primarily to produce a marketable article, say, sulphate of copper, in a cheaper manner than by the means generally adopted; and then, of course, in competition with other manufacturers the usual trade profits should result. As for the electrical energy yielded during the working of the batteries that is considered as a mere bagatelle; if it can be utilised for charging secondary batteries, and supplied to consumers for electric light or power purposes, so much the better, if not it is really of little consequence. We had hoped to be able to make our readers acquainted with this process some months ago, as an installation of the Perreur-Lloyd system was to be seen in London, but the description which we publish further on from a foreign source answers every purpose.

It is well, perhaps, to call to mind that this is the wild notion which, in the autumn, so completely fascinated one of the electric light committee of the Commission of Sewers, that the report on the City lighting was referred back pending further investigations into the method for illuminating London without steam engines or dynamos, and at less than half the cost of gas. At the time we could do no more than hint at the wonderful manner in which it was to be effected, and express our sympathy with the poor deluded commissioner.

The ordinary method of manufacturing sulphate of copper is so generally known that it is needless to enter into particulars respecting it; suffice it to say that whether by this mode of procedure or that of Perreur-Lloyd, metallic copper is dissolved in a heated solution of sulphuric acid. In the one case the treatment is simple in the extreme, in the other the process is exceedingly complicated. In the latter, the costly nitric acid depolariser forms an additional expense, and, notwithstanding the inventor's assertions, we venture to say that the condensed fluid from the vapours set free cannot be employed over again without additional acid being added. It is, moreover, necessary to employ a small boiler for the purpose of producing a supply of steam for heating the battery solutions, and this cannot be done at a negligible cost; it is safe, therefore, to assume, without going into further details, that the working cost for the production of a given quantity of sulphate of copper is greater in the Perreur-Lloyd apparatus than is the case when the usual method is used. Curiously enough, we believe that the French inventor only attempted to show that his productions could be obtained more cheaply than the market value at which they are sold; yet this was enough to impress a number of individuals—sane enough in the eyes of the world—with the idea that the process was a most remarkable one, and destined to revolutionise the sulphate industry. It goes without saying that if manufacturers found the electrical method of dissolving copper—and this is an older idea by far than M. Perreur-Lloyd seems to have any conception of—less costly than their present means, it would have been adopted years ago. Finally, if sulphate of copper could be produced and sold at the rate of 60,000 tons per annum, as the Frenchman asserts to be possible by his method, the material would at once become but a drug in the market. We have said enough to show the futility of the Perreur-Lloyd system; and, if occasion should ever demand it, we can back up our opinions with practical data which are absolutely convincing.

It is easy to understand how many well-intentioned people should rave about this scheme. The apparatus, especially when a number of secondary cells are being charged, and many incandescent lamps are brightly

gleaming, looks very imposing; the lengthy pamphlets descriptive of the system, in French and bad English, are confusing to even a chemist or an electrician; and when to this is added the inventor's explanation, the privileged persons invited to inspect the plant go away profoundly impressed by the nature of an experiment which they have utterly failed to understand. Of all projects of the kind yet brought before our notice this one is the best calculated to throw the unwary off their guard.

## THE MYSTERIES OF INSULATION.

THE experience gained in a submarine cable factory, as regards the behaviour of insulated wires, should be invaluable as regards electric light installations; but unfortunately it is very rarely the case that men who are engaged in electric light work have had the advantage of the training which is met with in such establishments. The result of this is that we continually meet with a display of ignorance both in practical work and in writings in the engineering Press which is most regrettable. In a recent issue of a contemporary an article appears on "Electric Light Regulations," in which we meet with such statements as the following:—"As to danger from bad insulation there is much more chance of a direct current breaking it down, as there is more chance of another leak elsewhere." As we have again and again pointed out, if a piece of cable core is found to be faulty, and the fault proves to be a stubborn one, it is alternations that are applied for the purpose of breaking down the defect. Again, in the article referred to, we find:—"Rule 6 provides that no high-pressure lead shall have an insulation of less than 50 megohms per mile. We trust the last expression may be altered into megohm miles. This degree of insulation seems too high to insist on just yet. . . . If the object of such a rule is to guard against cables breaking down, the insulation demanded is unnecessarily high." And again: "The general leakage through the earth does not really matter to anybody." These latter opinions are, we do not hesitate to affirm, absolutely incorrect; it seems impossible to make people understand what experience in cable factories and elsewhere has proved over and over again to be the case, that an insulation of 100 megohms per mile in a cable which, from the nature of the material with which it is insulated, should give at least 500 megohms, means a faulty cable which is certain to break down sooner or later under an electric strain, although *provided the insulation remained constant*, 100 megohms is more than 10 times as much as is necessary for working purposes. Another common delusion is the idea that common materials insulate less perfectly than those of a higher quality, as a matter of fact the best quality gutta-percha, for example, has in many cases a far lower insulation than that of an inferior quality; but then this lower insulation is due to *the nature of the material, and not to a defect in it.* With much that is said in the article in question we can agree, but we say—let writers leave the question of insulation alone unless they have had several years' work in a submarine cable factory.

Professional Opinions.

MR. J. E. H. GORDON sometimes makes reports upon things electrical, but to readers of the ELECTRICAL REVIEW he will probably be best remembered as the inventor of an alternating current machine which, from his own figures, gave a greater return than 100 per cent. of the power used to drive it. Some years ago he also reported upon an invention of the once celebrated, but now, alas! almost forgotten, John Banting Rogers, and now he comes to the fore again in connection with Mr. Theophilus Coad. In expressing his plain unvarnished opinion upon Mr. Coad's primary battery and miner's lamp, he considers the apparatus remarkably perfect and gives results which, *as far as he knows* (the italics are our own), have not yet been obtained elsewhere. Mr. Gordon says the solution of the battery is a novel one and the composition kept secret, but if his olfactory nerves have not been utterly upset, there surely could have been but little difficulty in detecting one of the ingredients; one which we may add is about the best thing of its kind for producing local action in a single fluid zinc-carbon element. The fact also that the battery, according to Mr. Gordon's measurements, gives "the extraordinarily high electromotive force of 2 volts per cell on open circuit," ought to have opened his eyes to the same extent as the odour should have affected his nose. Perhaps this gentleman is unaware that there are many galvanic batteries in use with an E.M.F. of over 2 volts per cell, and yet they are not looked upon as anything extraordinary? Mr. Gordon is careful to indulge in generalities only, but to say that the lamp gives ample light for all practical mining purposes for 12 hours with one charge of fluid is worthy of a heathen Chinee in its childlike simplicity, unless, indeed, he possesses the cat-like ability of seeing best in the dark; however, before the public supports Mr. Coad's inventions something more than this is surely necessary. Why are we not treated to a tabulated statement of E.M.F., current, battery resistance, watts in battery, watts in lamp, total watt hours, total ampère hours, theoretical weight of zinc, actual weight of zinc consumed, waste by local action, &c.? Those interested in such matters could then form their own opinion as to the merits of the battery; as it is the report is about as valuable as the paper upon which it is printed. The wonder is that professional men of reputation can be found ready to submit to the public such meaningless paragraphs as those from which we have quoted.

More Newspaper Science.

THE *Daily News* has of late rendered itself famous by a series of articles on electricity in the service of man, and its latest contribution on the Coad Exhibition is not the least remarkable of these extraordinary effusions. One would think that the writer had never heard of the employment of primary batteries as a means of producing electrical energy, for in the depth of his wisdom, the newspaper scribe gravely remarks: "It will be remembered that the electric light described in a recent series of articles in the *Daily News*, had its origin in the heat energy of coal; it remains to be seen whether the fluid battery method is applicable on a

large scale ; and, if it is, whether it is as cheap as the other method." The working of dental appliances by batteries is also a novelty to the daily press man, and he is completely lost in his contemplation of Mr. Coad's facetted lens, which, he says, multiplies the light enormously. What a pity it is that we should go on year after year striving to perfect electric lighting when a rushlight might, with the addition of this lens, be made to give 20 candle-power at least. The *Daily News*' representative goes into ecstacies of delight over the button-hole lamp, but he evidently forgets that only those possessing his own enthusiastic temperament would care to burden themselves with a battery weighing about 3 lbs., especially as the electric lighting of railway carriages is coming gradually into use, as is also the employment of the penny-in-the-slot method of providing reading lamps.

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No Bye-Products or Secondary Batteries.

MR. COAD did not speak on Saturday of an enormous fortune to be made by the sale of waste products, nor were secondary batteries used to show how it would be done. We have been cognisant of several occasions where primary batteries have been exhibited to demonstrate their power as light producers, and it has been explained that the accumulators present acted as reservoirs and steadied the light, whereas the whole current was drawn from the latter, and, in fact, the primaries had to be disconnected, because instead of charging the secondaries these latter were reacting upon them. In the sacred precincts of a building not far from the Adelphi, less than a century ago, the wonderful light producers—there never had been such—stood all in a row on the table ; the switch was turned on and a glorious glow appeared. A too curious friend of ours taking a walk round afterwards found the connecting wires to lead straight from the terminals of the E.P.S. cells underneath. The proprietor of the primary cells had evidently left the "fixing up" to some negligent hand. There wasn't much harm done, however, as the light was very good.

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Electrical Miners' Lamps.

THERE is no doubt a large field for electrical miners' lamps, and one great desideratum is that they should be as light as possible. Carbon and thin zinc plates are lighter than lead, and secondary batteries are in this respect at present at a disadvantage. There may be cases also where no dynamo is available for charging, but the labour in changing the liquid and zincs has to be considered in a comparison of the two systems.

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Cheap Law.

THE decision in the suit between the Continental litigants over the transformer patents will be seen in another column. We will only remark in connection with this matter that it is much to be desired that settlements could be as economically effected in this country as appears to be the case in Austria.

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Lamp Renewals.

WE have recieved some confirmation of the fact mentioned in our last week's "Notes" as to "lamp renewals" in Bradford, owing to the voltage variation occasioned by irregularity of working. We learn that the percentage of breakage is very great, due to the constantly changing pressure ; and it is further stated that on account of this unsatisfactory condition of the working of this station some of the shopkeepers are contemplating giving up the light. We have heard so much of the success of this attempt on the part of the Corporation of Bradford to supply the electric light to its townspeople, that it is unpleasant to learn that matters are not what they should be, and the interest of the town itself demands that early attention should be directed to remedying this serious defect. We have heard, also, that a certain amount of this unsteadiness is ascribed to the motor, and, in addition to these defects, we have been told on more than one occasion that there is considerable leakage in the mains. With the fact before us that the Corporation is about to borrow money for further extension of the electric light, it seems most desirable that the defect alluded to should be first eliminated, and, for this purpose, we beg to draw attention to an article criticising the performance of an engine in the REVIEW for April 18th, 1886, which may to some extent lead to suggesting a cause for the variations.

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The Bursting of Steam Pipes.

THE bursting of a steam pipe in the Sardinia Street Central Station reminds one of the disaster of a like nature which took place at Deptford last year. Such occurrences are unfortunate, and occasionally disastrous in their results ; luckily we hear of but one man being injured in this case. These incidents, although much to be deplored, are not likely to be the cause of any unnecessary alarm, for there is no reason why such casualties should occur more frequently in electric lighting works than in any other large engineering establishments.

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Underground Mains.

IN the continuation of this subject which appears in a contemporary last week, there appears a very large amount of matter with which our readers are doubtless very familiar, but there is one point which the author gives as the results of his experience, which we are compelled to notice. He remarks: "When exposed to the weather in London, my experience is that however well compounded such tapes and braids may be, the outer covering will be reduced in strength in a couple of years, or perhaps less, and that in two more years there will be very little power of holding together in the material." Either the deduction must be wrong, or the cables from which the experience is derived, must have been badly made ; for we have only recently examined cables which have been exposed to precisely similar influences for over two years-and-a-half, and their present condition, as regards the braid and compounding, is perfect. Many other cables of which we are aware have been up considerably longer and are in good condition. There are cables and cables, differing in manufacture and quality of material, and it is evident that those which are referred to by the writer of "Underground Mains" cannot be of the same excellence as those to which we have ourselves alluded. We are disposed to think that no cable manufacturer will endorse the opinion above given, and recognise the impossibility of protecting the braiding of a cable so that its durability is so short lived. We shall really be relieved when we learn what are the writer's experiences of "underground mains," of which nothing has yet been heard.

## THE PERREUR-LLOYD BATTERY.*

THE dominant idea of the system of generators invented by M. Perreur-Lloyd consists in the establishment of a manufactory of chemical products, in which electricity is considered as a veritable sub-product.

The generators are used for the fabrication of sulphates, and of simple or double chlorides of copper, iron, zinc, manganese, nickel, &c., whether for sale or to be employed in the manufacture of other more remunerative products.

Since the products formed by the combination of acids and bases giving birth to the electric current, possess a higher value than the sum of the values of their components, the inventors believe they can reduce the cost of the electric current to *nil* by assembling them for the above-mentioned purpose.

In a word, the system includes the kidnapping, so to speak, of the electric current wherever it has its origin by some one of the reactions used in chemical industry.

The inventors have sought to assemble together in the most economical manner the metallic salts which are formed within the interior of the generators by turning to account the difference in solubility of these salts when warm and when cold; the temperature rises during the working, owing to the heat which is caused by the interior resistances of the batteries; in case this is not sufficient, a jet of steam brings up the solutions to register the number of degrees Baumé corresponding to their crystallisation by the simple cooling they undergo on leaving the generators, the walls of which are, moreover, sufficiently thick to make the loss of heat by radiation very slight.

The depolariser is obtained by the regeneration of the nitric acid, which is used for this purpose.

The nitrous vapours formed by the reduction of the nitric acid surrounding the carbon electrode make their way into condensing vessels analogous to those employed in the fabrication of sulphuric acid, where, on contact with water, they form a combination of nitric and nitrous acids and in this way the oxygen of the air is the ultimate depolariser.

The generator is composed of a vat offering resistance to heat and acids. The upper portion of this vat is intended to receive the electrodes, while the lower portion forms a reservoir for the solutions. Glass plates divide the generator into compartments, each of which co-operates in the formation of a distinct element.

The elements are constituted thus: between the walls of the elements are placed flat porous jars, which are supported by ledges formed in the thickness of the sides of the vats; under these jars is a hollow place called the reservoir.

Each element comprises one or several porous jars, in which are placed carbons of a thickness which increases progressively towards the upper extremity; between the porous jars copper plates constitute the soluble electrode.

The reservoir communicates directly with the portion of the vat in which are the soluble electrodes.

The advantage of this reservoir is that it enables us to approximate the electrodes as closely as we may desire in the upper portion of the vat, and at the same time to have a volume of exciting solution, which is much more considerable than that of the depolarising solution.

Since, theoretically, it only requires a third of the equivalent of nitric acid to oxidise the hydrogen which dissolves the combination of an equivalent of acid with the soluble electrode, and since, moreover, this last named acid is only used in a diluted state, it is evident that the depolarising solution being concentrated, the relation between the volumes of the exciting and depolarising solutions must often be considerable; it is necessary, in fact, for the proper working of the apparatus that the two solutions should be exhausted simultaneously.

The generators are covered with glass plates; the carbons of the porous receivers, as also the connections, of the soluble electrodes, issue out of this casing. The latter presents a slant which facilitates the draught through the chimney in the upper portion of the generator. This disposition has another object: the battery in full working becomes heated, the water steam condenses upon the casing, and absorbs, in some measure, the nitric vapours that are set free; the nitrous products thus formed, are received into a gutter, fashioned in the anterior portion of the generators at the precise spot upon which the casing rests.

The generators are always placed lower than the large reservoirs in which the depolarising and exciting solutions are prepared. The reservoirs communicate by means of pipes with tubes that are placed in the fore part of the generators and of the crystallising vats respectively; the tubes communicate by branch pipes fitted with taps, with each one of the porous jars. The supply is effected through a tube in communication with the depolarising reservoir by opening the taps of the branch pipes successively. To empty the jars the tubes are placed in combination with a receiver, into which the discharge is made, and each jar is emptied in the same way by means of the taps.

The battery circuit is closed upon the accumulators. The sulphates or chlorides are formed in the interior of the generators, and the nitrous vapours are set free to undergo condensation. When the solution in the latter registers 20 degrees, it is again made use of as a depolariser by mixing it with one or two volumes of sulphuric acid. The depolarising solution, when exhausted, is employed as an exciter.

The reservoir is heated by a steam pipe.

* *La Lumiere Electrique.*

## SOME EXPERIMENTS ON THE ELECTRICAL LIGHTING OF RAILWAY CARRIAGES.*

*Paris and Orleans Railway.*

THE Orleans Company in April, 1883, made an introductory experiment at their station with 20 Faure accumulators, each weighing about 6 kg., and calculated to contain about 4·4 kg. of effective material. Four Swan lamps of 36 volts and 0·75 ampères were employed. The intensity of the light diminished rapidly, and at the expiration of six hours became ineffective. Each lamp had expended about 5 kg. of accumulator per hour.

The first attempt made at train lighting (May, 1883) was in a carriage of which each compartment was illuminated by two lamps of 10 volts and 2 ampères and of a nominal power of six candles. It was found that the expenditure of 2 ampères per lamp per hour entailed the employment of far too great a weight of accumulators during a long journey without supervision and a renewal of the cells.

A second attempt was made in September, 1883, on an outward and return journey between Paris and Bordeaux lasting seven hours. 320 kg. of accumulators were used with eight Swan lamps. At the expiration of a few hours the light became too weak.

These experiments led to the conclusion that at least 400 kg. of accumulators per carriage, with lamps of 36 volts and 0·75 ampères would be required. It would be necessary to employ 19 to 20 cells of 20 kg. at first, and have four or five spare cells for the remaining portion of the journey; and, further, in order to maintain a constant light, personal supervision would be necessary in order to avoid a too powerful current at first and an insufficiently strong one at a later period.

The Orleans Company consequently renounced the

* From a paper read before a meeting of the Société Internationale des Électriciens, by Mons. J. Sarcia, December 4th, 1889.

idea of electrically lighting their trains and adopted mineral oils.

*Pennsylvania Railway.*

The first experiments of any moment made on train lighting by this company were effected in April, 1885. Eight saloon carriages were each fitted with 10 Brush-Swan lamps of 45 volts and 1 ampère with an illuminating power of 12 candles. Twenty-four cells of Brush accumulators, Planté type, were used, weighing 600 kg., and coupled in series.

This experiment failed for the following reasons :—

1. The capacity of the batteries was insufficient, giving only five hours of lighting.
2. The positive plates only lasted a year.
3. The replacing of the accumulator boxes was difficult owing to their weight (300 kg.) and position.
4. The lamps were too fragile, the breakage amounting to 4 per cent. per day.

At the end of 1887 the Brush accumulators were removed, and Faure accumulators (type 7 B) of the Electrical Accumulator Company, some of the same company's type, 23 C, and some of the Julien Electric Company's type, 19 B, were substituted, employing Edison lamps of 23 volts. The results of this change have been extremely satisfactory, and the replacing of the electric light by gas, which was commenced on the failure of the first experiment, has been discontinued.

*Boston and Albany Railroad.*

After some preliminary experiments, trains between New York and Boston have, since March, 1887, been electrically lighted.

Each carriage has 22 lamps of the Weston pattern, of 60 volts and 1·1 ampères, and of 16 candle-power. A carriage, however, has been fitted up with Edison lamps, and these have given so much satisfaction that it is proposed to use them exclusively in the future. Each carriage has 60 cells of Julien accumulators in two groups, each of which feeds 11 lamps ; each group contains 27 cells in series, with 3 in reserve. Each cell weighs 17 kg., having an effective weight of 12 kg. The lighting lasts for nine hours, but there is sufficient reserve for one or two hours more if necessary.

*Pullman Palace Car Company.*

The experiments carried out by this company were commenced in 1887, between New York and Chicago. Each carriage contained 30 cells of the Electrical Accumulator Company's type 7 B. Another train was fitted with the Julien type 19 B accumulator. Both these types have given equal satisfaction. The difficulties attending the charging of the accumulators at each terminus have led the Pulman Company to place in a waggon attached to each train, a dynamo worked by a fast speed steam motor.

*Canadian Pacific Railway.*

The first train in Canada electrically lighted was one running between Montreal and Ottawa, and the success of this experiment has led to a great extension of this method of illumination on the Canadian Pacific system.

*North-Eastern Railway of Switzerland.*

On a train running between Zurich and Richtersweil, a carriage of four compartments is electrically lighted. Each compartment has one lamp and there are two on the platform, making six lamps altogether, each of 15 volts and 0·24 ampère, with a lighting power of 10 candles. A battery of accumulators with 8 cells, weighing 180 kg., was used. Each cell has a capacity of 150 ampère-hours, allowing a consumption of 3 watts per candle. The lighting can be maintained for 13 hours. The experiment has proved the advantage of the electric light over Pintsch's gas, used in the same train, as for the same number of burners and hours of lighting the gas reservoirs are double the weight of the electric accumulators.

*Railways of Western Switzerland and the Simplon.*

This company commenced in December, 1888, to light one of its carriages with seven Khotinsky lamps of 18 volts, requiring a total current of 9·6 ampères (three lamps of 10 candle-power, two of eight, and two of six). A battery is used of nine secondary cells of 15 plates, Huber system, furnished by the Blanc Works at Marly-le-Grand (Fribourg). The weight of each cell is 8·06 kg., with a capacity of 120 ampère hours (15 ampère hours per effective kg). The lighting lasted about 12½ hours. After 800 hours of illumination neither accumulators nor lamps showed the least deterioration.

*The Northern Railway of France.*

After experiments lasting over two years, it was concluded to illuminate the carriages of the Club Train, running between Paris, Calais, Dover and London, with the electric light. Three saloon carriages and a dining car are each fitted with 21 incandescence lamps, the kitchen with seven and the smoking room with eight. The lamps are of the type called "French Homogeneous," and are run with a difference of potential of 25 volts and 0·7 to 0·8 ampères. Their illuminating power is about seven candles. The lamps are fed by a battery of 16 accumulators of seven plates, each cell weighing 31 kgs. and containing 17½ kgs. of effective material. The total weight of the accumulators and cases is 580 kgs., and the capacity of each cell is 175 ampère hours. The practical duration of the lighting is from 10 to 12 hours. The plates of the accumulators are of a new type called "Plaque type Wagons Lits."

The cost of lighting, including the charging and maintenance of the accumulators, the renewal of lamps and labour, amounts to 0·006 francs per lamp per hour. If there be added to this figure 10 per cent. of the original cost of installation as interest, and for the renewal of all material and apparatus in the carriages, the cost would amount to 0·0253 francs per lamp per hour. Although it is not yet positively determined that the 10 per cent. is a sufficient allowance, there is yet a margin, since the cost of lighting the company's first-class carriages with oil amounts under the same conditions to 0·038 francs per lamp per hour.

The lighting, it is said, has given complete satisfaction, although having been in operation for only four months, it is rather early to assume a complete success.

A further experiment has been made on a tramway train between Paris and St. Denis. A carriage containing 112 seats is illuminated with 13 lamps of 25 volts (7 candle-power) supplied from a battery of 16 accumulators of the same type as those employed in the Club train.

REMARKS.*

*Orleans Railway.*—The total weight of the 20 accumulators appears to be 120 kg., of which 88 kg. are effective material, or say, 20 kg. per lamp ; at the rate of six working hours, this would equal 3·6 effective kg. per lamp per hour.

The reference to the expenditure of 5 kg. of accumulator per lamp per hour, must refer to the gross weight, not the effective, of accumulators. On this assumption the word "expended" is misleading. The lamps employed were probably of 8 candle-power.

*Pennsylvania Railway.*—The earlier experiments on this railway seem to have been carried out on much the same lines as those on the Orleans road. It is noticeable that when the lower voltage lamps were employed one of the difficulties, at least, seems to have been overcome, though no attempt appears to have been made in the direction of reducing the weight of the accumulators.

*Boston and Albany Railway.*—These experiments would show that having only 27 cells in series, the 60 volt lamps are evidently working under less than their full candle-power.

The gross weight of the cells amounts to 1,020 kg., or say about 46 kg. per lamp of 16 candle-power. If we compare this with the Orleans Railway experiments, we find a considerable saving in weight, that is to say, 2½ kg. as against 3·6 kg. per lamp per hour.

* These are our comments.—EDS. ELEC. REV.

*North-Eastern Railway of Switzerland.*—We do not quite understand how the current, in these experiments, is given as being 0·24 ampères; surely this should be 2·4 ampères. Even with this figure there appears to be some error, as 3 watts per candle are allowed.

Comparing this experiment with those previously mentioned, a further reduction in weight of accumulators appears to have been made, the weight per 8 candle-power lamp per hour being less than 2 kg.

*Railways of Western Switzerland and the Simplon.*—In these experiments, comparing the data with the preceding examples, we find the weight of accumulators still further reduced, the figure coming out to less than 1 kg. per 8 candle-power lamp per hour. Although the lamps are run at a rather higher efficiency, it is interesting to note that neither lamps nor accumulators show the least deterioration.

*Northern Railway of France.*—In this case the weight of accumulator per 8 candle-power lamp per hour appears to be 2½ kg.

As to the cost of the lighting, we should question the accuracy of the figures given. The only point of interest in the foregoing experiments is the progress made in the reduction of the weight of accumulators, and of this the case of the railways of Western Switzerland is a notable example.

The method adopted of giving the weight of accumulators "expended" is, of course, not a technically correct expression. The gross weight of accumulators carried is naturally an important factor so far as the railway companies are concerned, but the "effective" weight, or the weight "expended," only concerns the manufacturer of the cells.

## THE FRENCH GOVERNMENT AND THE EASTERN TELEGRAPH COMPANY.

WE have already made mention of the agreement entered into between the French Government and the Eastern Telegraph Company. The following more detailed account of the arrangements made may be of interest to our readers:—As the result of protracted negociations, lately brought to a sucessful termination by Mons. Coulon, Chief of Posts and Telegraphs, a decree has been promulgated, dated the 17th January, 1890, approving of two contracts entered into between the President of the Council, the Minister of Commerce, of Industries, and of the Colonies, and the Eastern Telegraph Company, renewing, under very favourable conditions as regards France, the former contracts which had expired.

The object of one of these agreements is the providing of a special wire between Marseilles and London, to be employed for the transmission of telegraphic correspondence between Great Britain and the East, the charge for this accommodation being considerably increased.

The tenour of the other contract deals with the landing and working of the submarine cables between Marseilles, Bona and Malta. The Eastern Company is authorised to land a third cable at Marseilles. The company agrees to transmit at half rates all official telegrams exchanged between France, Algeria, Tunis, Malta, Egypt and Obock. A fresh clause stipulates for a very large reduction of tariffs in favour of French press telegrams, written in ordinary language, exchanged with the extreme east.

For communications with Cochin-China, Annam and Tonquin, the maximum of cable rates for special press telegrams is fixed at three francs per word; with other countries the tariff must not, under any circumstances, exceed the rates charged for English press telegrams.

The Government always reserves to itself the right, in certain determined circumstances, to take into its own hands the working of all the company's cables at the points where they are landed on French territory.

## THE PELTIER EFFECT AND CONTACT E.M.F.

THE review of Prof. O. J. Lodge's "Modern Views of Electricity" which appeared a short time ago in *Nature*, has produced a rather unusual, but, at the same time, interesting discussion between the author and his reviewer.

In the book in question, Prof. Lodge gives a bright and accurate account of many of the most recent speculations concerning the nature of electrical phenomena. Most of his chapters are devoted to the consideration of the ether in the medium separating the charged bodies in an electric field. This might have been expected from the preface, in which the professor says, "Few things in physical science appear to me more certain than that what has so long been called electricity, is a form, or rather a mode of manifestation of the ether."

Now the reviewer questions whether of late years too much attention has not been diverted from the condition of the charged bodies themselves to that of the ether in the medium existing between them; and perhaps his review is throughout slightly tinged with this idea, which has possibly prevented him from bringing a perfectly open mind to the judgment of a book which is manifestly well done, and appears at a time when there is an obvious demand for it.

Without commenting upon the minor points concerning which the professor and his reviewer are at variance, the subject upon which they chiefly join issue is one which has been a matter of considerable discussion and research of late years, and has been from time to time noticed in these pages. The reviewer charges Prof. Lodge with having "stated that the amount of the Peltier effect shows that the difference of potential between zinc and copper is only a few micro-volts." This and the immediate contact he characterises as misleading, and goes on to state that "the Peltier effect, however, without further assumption cannot tell us anything about the absolute magnitude of the difference of potential between the metals; it can only give us the value of the temperature coefficient which is equal to the Peltier ffect divided by the absolute temperature."

In reply, the professor points out that he has argued the whole matter at length in the *Philosophical Magazine* for March, 1886. The paper is entitled "On the Seat of the Electromotive Forces in Voltaic and Thermo-electric Piles;" it will be remembered that this constituted a reply to certain criticisms of Profs. Ayrton and Perry, made before the Society of Telegraph Engineers. On page 269, *Phil. Mag.*, Vol. 21, we find that Prof. Lodge writes: "The mean of the electromotive force at any point of a circuit is the work done per unit electricity conveyed past that point;" that is to say,

$$d\,\mathrm{E} = \frac{d\,\mathrm{W}}{\mathrm{Q}}$$

This statement the professor is right in saying has never been disproved, and in a letter to *Nature*, p. 80, Vol. 41, he remarks: "Until this is disproved I regard it as axiomatic, and so regarding it, I hold that what I have said about contact E.M.F. is true." He maintains that this is the only "further assumption" needed.

The reviewer thereupon replied (*vide Nature*, Vol. 41, p. 102) that "the only reason for calling it an axiom is, that it cannot be proved;" certainly a very bold remark to hazard, especially in the face of recent work by Potier and others, which at least tends in the direction of its proof. This is followed up with an argument which some of our readers may have heard before; he says:

"Let us take a simple case. Suppose we have a condenser the plates of which are made of two different metals metallically connected, and that this condenser is placed in a vacuum, then, so far as I can see, Prof. Lodge's principle must lead to the conclusion that the difference of potential between the plates of the condenser is proportional to the Peltier effect; but if this is so, it is quite easy to prove by the second law of thermodynamics, that if the system is regarded as a heat

engine, the Peltier effect cannot vanish except at the zero of absolute temperature."

This argument apparently proves that a true E.M.F. at contact between two metals cannot be the sole cause of the Peltier effect unless the latter be simply proportional to the absolute temperature.

The professor, however, points out (*vide Nature*, Vol. 41, p. 224) that this reasoning depends upon those properties of a vacuum which are assumed by the argument, viz. :

1. That a perfect vacuum is an absolute non-conductor of electricity.

2. That no contact E.M.F. exists between a metal and a vacuum.

3. That vacuum has specific inductive capacity.

But, as everyone knows, these assumptions are not generally allowed. Prof. Lodge himself only admits (1) and (3) provisionally, and entirely disbelieves in (2). Unless they are all allowed to be true, the argument breaks down.

Prof. Lodge holds that the Peltier effect gives the E.M.F. at the junction of the metals in contact, and, as he says, there is much ground for the assertion ; for it can be shown, without any difficulty, that in a simple A, B circuit, with junctions at $t_1$ and $t_2$, the total E.M.F. is represented by the equation

$$E = \Pi_1 - \Pi_2 + \int_{t_2}^{t_1} (\Theta_A - \Theta_B)\, dt.$$

As he points out, this equation is undeniably true when the $\Pi$ are interpreted as heat efficients ; and he contends that it is also an identity and capable of being at once interpreted when these symbols stand for contact E.M.Fs.

The recent researches of Potier and Lippmann, which have been noticed in this journal, as well as those of Pellat, Blondlot, and other foreign scientists, certainly appear to indicate the possibility ere long of supporting Prof. Lodge's contention by the results of direct experiment. Potier distinctly stated before the Academy of Sciences at Paris a short time ago, that the so-called Peltier effect *is* a measure of the E.M.F. existing at the contact of two metals, and, as was obvious from his discourse, this is not a mere groundless theory, but sufficiently warrantable by facts.

It goes without saying, that this subject is one of absorbing interest to those scientists who have investigated it, and its importance, as well as the prominence given to it by this late discussion between the reviewer and the reviewed, ought to attract the attention of many of our rising experimentalists.

## ON PHYSICAL FIELDS.*

By A. E. DOLBEAR.

WHEN the physical state of a body re-acts upon the medium that surrounds it so as to produce in the medium a state of stress or motion, or both, the space within which such effects are produced is called the "field" of the body. When a body is made to assume two or more physical states simultaneously, each state produces its own field independent of the existence of the others : hence two or more fields may co-exist in the same space. For instance : if a magnet be electrified, both the magnetic and the electric fields occupy the same space, and each as if the other did not exist.

### PROPERTY OF VARIOUS FIELDS.

I. *The Electric Field.*—Suppose a glass rod be electrified with silk or cat skin. It is experimentally known that other bodies in its neighbourhood are physically affected by its mere presence without contact, and various motions result which are commonly attributed to electric attraction or repulsion. The phenomena are explained as due to the stress into which the neighbouring ether is thrown by the electrified body, the stress re-acting upon other bodies, and moving them this way or that as the stress is greater here or there. Suppose an electrified mass of matter remote from any other matter, in free space. The field, or the stress that constitutes it, is found to vary in strength inversely as the square of the distance from the body in every direction about it, which shows that the effect upon the ether is uniform in all directions, and that for such a stress under such conditions the ether is isotropic. Experiment shows that this kind of a stress travels outwards with the velocity of 186,000 miles a second, or the same as that of light, which shows that the velocity of motion in the ether depends solely upon the properties of the ether, and not at all upon the source of the disturbance. If this assumed electrified mass of matter were the only matter in the universe, then its electric field would be as extensive as the universe, and any electric change in the mass would ultimately re-act upon the whole of space, and be uniform in every direction. If, however, there be another mass of matter in proximity to the first, the disposition of the stress is altogether different ; for instead of being disposed radially, as in the first case, the field is distorted by the re-action of the distressed ether upon the second body. The so-called "lines of force" bend more or less towards the second body, and the field stress becomes denser between the bodies at the expense of the field more remote. If this advancing stress in the ether from an electrified body be called radiation, and it seems to be an action of that kind, then it appears that the direction of such radiation depends upon the existence of other bodies in the ether. It is truly rectilinear no further than the shortest distance between the two bodies.

The electric field thus produced, and thus re-acting upon another body, develops in the latter an electrical condition—that is to say, it electrifies it ; and the process we call "electric induction," to distinguish it from the transference of the electrification by contact, which is called "conduction." In the process called induction there are two transformations : in conduction there is simply a transference, and no transformation. The experimental fact is this : an electrified body sets up in the ether a stress of such a nature that, by its re-action upon another body, the latter is brought into a condition similar to that of the first ; that is, it electrifies it.

II. *The Magnetic Field.*—A magnet in like manner sets up in the ether a stress that is propagated outwards with the velocity of light. The physical character of this stress is such that iron and some other substances upon which it can re-act are thereby rendered magnetic. Their molecules are re-arranged. On the supposition that a piece of iron were suddenly magnetised in any way remote from any magnetisable substance, the magnetic field would spread radially, having a spherical surface. As soon, however, as a piece of magnetisable substance was reached, the re-action of the ether upon it would begin ; and the so-called magnetic lines of force will now be curves, and the equipotential surfaces will no longer be spherical. The distortion will depend upon the size, shape, and quality of the second body, as well as upon the strength of the field.

This process is called "magnetic induction." The magnetic field differs from the electric field in this important particular : the latter has no selective property, but re-acts upon all substances, while the magnetic field re-acts upon iron and a few other substances, and but slightly, if at all, upon most bodies. They are alike, however, in this : their equipotential surfaces are determined by the presence or absence of other bodies.

A magnet then sets up such a physical condition in the ether that its re-action upon another body brings the latter into a condition similar to that of the first—that is, it magnetises it.

III. *The Thermal Field.*—An isolated hot body becomes cool by a process called radiation. It is explained by saying that the atomic and molecular vibratory motions that constitute the heat of the body, set up undulatory motions in the ether. These undulations are propagated with the velocity of light, certain wave-lengths being light. The path of a ray is

* *Science*

straight, and is continued indefinitely outwards, to the boundary of the universe if there be a boundary; if not, then to an infinite distance. A hot body has a field, as well as an electrified or a magnetised body.

Experimentally we know that when these undulatory motions called rays fall upon other matter, it becomes heated in consequence; and we also know that the energy acquired by the second body from the radiations depends rigorously upon the area exposed to them. It is customery to say that the intensity of light varies inversely as the square of the distance from the source, when intensity means energy. This is true, however, only for equal intervals of time; for if a body at unit distance was exposed to radiations from a constant source for one second, and another similar body at double the distance was exposed for four seconds, each unit of surface would have received the same amount of light or radiant energy.

The presence or absence of another body in the thermal field makes no difference in the strength of the field in other directions; in other words, the absorption of radiant energy of this sort makes no matter of difference in the direction of other rays that have not been stopped. I am not aware of the existence of any evidence that a ray of radiant energy of any wave length is ever deflected from its rectilinear course except by a change in the density of the medium through which it passes, and not then if the incidence be normal. In this respect the thermal field is entirely unlike the other two fields. In addition to this, let it be remembered that a hot body continues to impart its energy to the ether until its income equals its expenditure, according to Prevost's law of exchanges; so, if there were but a single hot body in the universe, it would impart its energy to the ether, and approach infinitely near absolute zero; while an electrified body or a magnet would be perfectly insulated, and, so far as is known, would lose none of its properties, however long it was thus kept. There is no static condition in heat phenomena: exchange is constant. These facts indicate that light or radiant energy is no more an electro-magnetic phenomenon than magnetism is a thermal phenomenon, but that it is one of a distinct order.

That point is immaterial here, for what I wish to call attention to is the fact that a heated body sets up in the ether such a physical condition that its re-action upon another body brings the latter to a condition similar to the first; that is, it heats it.

IV. *The Acoustic Field.*—There is another physical field with which all are acquainted, though it has not hitherto been called by that name. I refer to the phenomena of sound. Suppose a bell be struck: sound-waves in air are formed, that travel outwards, and have the same geometrical space relations that other fields have. So long as the medium is uniform, the field is uniform, and the energy of the sound-waves per unit surface and unit time varies inversely as the square of the distance from the force. When such sound-waves fall upon other masses of matter, they are absorbed and reflected. Those that are absorbed set the body in vibratory motion similar to the original vibrating body; that is to say, they produce sound. If such second body upon which the waves fall happens to have its own vibratory rate in accordance with the time-rate of the incident waves, the effect is cumulative, and the body may be made to visibly as well as audibly vibrate. If not, the vibrations are said to be forced vibrations; but in every case every body in an acoustic field is made to vibrate. Now, there is the same distinction between the vibratory motions of the bell and the air waves that result from them as there is between heated molecules and the undulations in the ether; but acoustical terminology has not hitherto been so seriously incommoded by the failure to make the distinction as has been the case with heat phenomena. As sound phenomena are treated as special cases in kinetics, the space within which sound waves are produced by the vibratory motions of a body may be spoken of as the acoustic field; and here, as in the other three cases, we have the fact that a sounding body sets up in the medium about it such a physical condition as, by its reaction upon another body, brings the latter into a vibratory state like the first.

These various physical relations may be thus generalised: When a mass of matter acts upon the medium that is about it, the latter is thrown into such a physical condition or state that its reaction upon another body always induces in the second body a state similar to that of the first body. This has a much wider application than most physical laws; for it embraces phenomena in mechanics, heat, light, electricity, and magnetism.

## THE WENSTROM DYNAMO.

A DYNAMO of this make was recently sent to the electrical testing bureau of the Johns Hopkins University, where it was submitted to a series of tests, the results of which are given below, under the signatures of Drs. G. A. Liebig, Louis Duncan, and W. F. Hasson. The dynamo tested was designed to give an output of 400 ampères, at 110 volts, running at a speed of 500 revolutions per minute; while the speed under which the tests were made was only 330 revolutions per minute.

"The dynamo electric machine sent to us for examination, a report of which is contained in the following pages, was described by the manufacturers as an 800-light dynamo, and was stated to absorb energy, when doing full duty, at the rate of about 60 horse-power.

"Having our source of motive power and testing apparatus already in place for the purpose of conducting some experiments on other dynamos, the following tests were made (through the kindness of Mr. F. Hambleton, who consented to allow the bureau the use of a part of the works under his charge), at the plant of the Consolidated Gas Company of this city (Baltimore).

"Here we had set up an Armington and Sims engine of about 70 horse-power capacity; belted to which was a Tatham dynamometer, which in turn was connected by a belt with the dynamo under examination. At a convenient distance from the dynamo were located the lamps and resistances (resistance coils), through which the current furnished by the former was allowed to flow, as well as the various instruments employed in the electrical measurements. Steam for the engine was furnished by a set of boilers located near by, but in a separate building.

"The source of motive power was, as stated before, an Armington and Sims engine, rated, nominally, at about 70 horse-power when supplied with steam at about 80 lbs. pressure. The normal speed of the engine was about 275 revolutions per minute, but this could be varied within limits of a considerable range, without any serious interference with the action of the governor.

"For measuring the power supplied to the dynamo, there was emplyed a dynamometer originally designed by W. P. Tatham of Philadelphia. This instrument was the same as that used some years ago by the committee appointed by the Franklin Institute of Philadelphia to conduct the competitive tests of dynamos exhibited at the Electrical Exhibition held in Philadelphia in 1885.

"For measuring the current furnished by the machine, there were employed two methods, the full-load current being 400 ampères—too great for any single instrument in our possession—a part of this was measured by a Thomson balance, and part by observing the potential difference between the ends of several heavy strips of German Silver immersed in oil. The latter method is known generally as the method of fixed resistances, and the apparatus referred to was standardised by observing the difference of potential at its terminals, when a current of known value, as

measured by the Thomson balance, was allowed to pass through it.

"In the measurement of electromotive force there was used a Weston voltmeter, received only a few days previously from the laboratory of Mr. Edward Weston, where it had been standardised. This, however, as well as the other measuring apparatus, was, after the completion of the test, carefully calibrated in the physical laboratory of this university.

"It may be stated that owing to the construction of the measuring apparatus employed, and also to the circumstances that a considerable distance separated the instruments used from the dynamo, no magnetic influence could have interfered with the accuracy of their indications. Before measuring the power absorbed by the dynamo, the dynamometer was run without load, in order to determine its own friction. This amount of power consumed was, in all cases, subtracted from subsequent measurements. The friction of the dynamo itself was determined by running it on open circuit, and with the brushes removed.

"The order of making the tests was as follows: first, the dynamometer was run without load; second, the dynamo was run on open circuit, brushes removed (this measurement gives friction of dynamo); third, the dynamo brushes were placed in position (this measurement represents losses due to friction in bearings, losses due to heating of field magnet wires, losses due to reversals of magnetism of armatures, core, and losses due to Foucault currents in the armature). These losses are, for a given speed, nearly constant. After this, the dynamo circuit was made, and measurements of power, current, and electromotive force at different loads were begun. The following table gives the results of the several determinations:—

| Current. | Electro-motive Force. | Horse-Power. | Dynamometer Horse-power. | Loss. | Losses, Friction, Reversals, &c. | Losses, Current² × Resistance. | Efficiency. |
|---|---|---|---|---|---|---|---|
| 134·8 | 114·0 | 20·6 | 24·97 | 4·4 | 4·4 | 17 | 82·5 |
| 194·1 | 115·6 | 30·1 | 35·3 | 5·2 | 4·5 | ·38 | 85·2 |
| 371·6 | 98·3 | 49·0 | 54·5 | 5·5 | 3·5 | 1·30 | 89·9 |
| 400·0 | 110 0 | 58·9 | 64·7 | 5·8 | 4·1 | 1·50 | 91·0 |

"Speed of dynamo, 330 revolutions per minute."

## PRACTICAL STANDARDS OF ELECTRO-MOTIVE FORCE.

THE present standards of E.M.F., excellent though they are for scientific laboratories, have not appeared to us (MM. Baille and Féry in *l'Electricien*) to combine all the qualities which are necessary for ordinary measurements in industrial laboratories.

They are for the most part more than sufficiently exact, but are too delicate in construction; in their setting up it is necessary that the materials should be pure, and some of them are apt to be affected by the air or the light.

A practical standard ought to combine the following qualifications—simplicity in construction, the use of ordinary commercial products, be easily kept in order, a practical absence of polarisation with resistances higher than 5,000 ohms, internal resistance slight enough to allow of its being ignored in comparison with that of the galvanometer circuit.

The Daniell element, which fulfils all these conditions, has nevertheless the disadvantage of necessitating frequent setting up; moreover, the porous vase which it contains increases the internal resistance of the battery, and, owing to the metallic incrustations which are formed in it may, by closing the element upon itself, falsify the measurements entirely.

It has occurred to us that by substituting for sulphate of copper a less soluble salt, we might get rid of the porous vase and of the disturbances which result from it without too greatly augmenting the polarisation.

Salts of slight solubility, like that of lead, sulphate, and especially chloride, gave us very satisfactory results.

The element is formed of a leaden strip inserted in a glass tube which has the lower extremity bent, and contains chloride (fig. 1); the electrode is formed of a sheet of amalgamated zinc; the whole is immersed in a solution of chloride of zinc of about 1·16 density. When the battery is working the zinc becomes dissolved and the chloride of lead reduced. This reduction is slow and very regular; a very clear line divides the reduced lead from the chloride.

The battery therefore remains unaltered, only the liquid slightly increases in density; for this reason the volume of liquid ought to be large enough to prevent these slight variations in density from having any perceptible effect upon the value of E.

The following table gives the value of the E.M.F. in relation to the density of the solution.

| Densities. | Electromotive Force in Volts. |
|---|---|
| 1·005 | 0 550 |
| 1·05 | 0·522 |
| 1·095 | 0·516 |
| 1·157 | 0·500 |
| 1·18 | 0·497 |
| 1·24 | 0·490 |
| 1·32 | 0·470 |
| 1·40 | 0·460 |

*Note.*—The E.M.Fs. shown upon the table were obtained by comparison with the the Fleming standard (solution B).

The relative values are exact; perhaps it might be necessary to multiply them by a factor very closely allied to the unit in order to restore them their E.M.F. signification in legal volts.

We observe that up to 1·16, about an error of $\frac{1}{100}$th in the density only gives a variation of 0·0015 volts.

The densities have been calculated by the densimeter, except as regards the one which gives 0·5 volt exactly, that having been determined for the sake of greater exactitude by the bottle method.

Within ordinary limits variations of temperature have no practical influence upon the value of E.

After some days the zinc in the battery becomes covered with a light leaden growth.

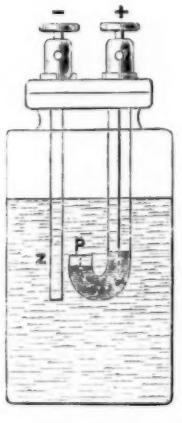


FIG. 1.

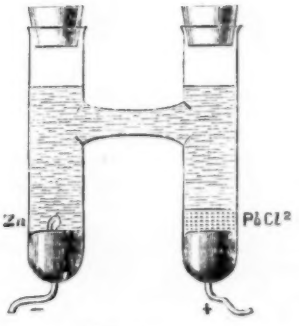


FIG. 2.

We have ascertained by measurements, allowing of the valuation of $\frac{1}{1000}$ volt, that this deposit lowers the E.M.F. by 0·015 volt, whatever may be the quantity of the lead deposited.

For measurements with the condenser or the electrometer we adopt the following arrangement: a tube in H form receives into each of its branches (fig 2.) an amalgam of saturated liquid lead; we insert in one of the branches some fragments of zinc previously amalgamated; the amalgam enclosed in the other branch is covered with chloride of lead; two platinum wires fuzed into the glass establish electric communication with the

mercury. It is as well to insert in the horizontal junction tube a small asbestos or cotton plug to oppose the mechanical passage of the pulverulent chloride from one branch to the other.

The E.M.F. of the element in H is greater by 0·003 volt than that of the ordinary element, because the free metallic lead at the positive pole is amalgamated in proportion to its reduction, and we have already seen that the combination of the two metals absorbs 0·06 calorie per equivalent of lead (*Annales de Physique et Chimie*, June 1889).

The internal resistance of the element shown in fig. 1 is about 20 ohms; that of the battery in H may reach 200 ohms.

*The Nature of the Materials used.*— Although chlorides of lead precipitated cold or hot furnish the same E.M.F., we prefer warm chloride which, by reason of its crystalline texture, is more easily washed and is reduced with greater regularity.

In substituting for the solution of pure chloride of zinc, a liquid of similar density obtained by the action of ordinary chlorhydric acid upon ordinary zinc, we notice no alteration of E.M.F.; the foreign metals (copper, lead), which these products enclose are in fact insoluble or are precipitated under these conditions. It is, nevertheless, necessary that the chloride should be as neutral as possible, an acid liquid producing an augmentation of E by some hundredths of volts.

To avoid this source of error it is only necessary to leave the liquid long enough with the zinc.

The polarisation, though more marked than in the Daniell element, is yet much less than that of the majority of standards in use; the E.M.F., however, recovers its normal value very quickly.

## DERI v. GAULARD AND GIBBS.

THIS suit, which has just been decided at Vienna in favour of Herr Deri, had for its object to annul certain claims of the Austrian-Hungarian patent of Messrs. Gaulard and Gibbs. The Imperial and Royal Ministry of Commerce in concert with the Royal Hungarian Ministry of Commerce has decreed that the petition of Max Deri, engineer, of Vienna, against Lucien Gaulard and John Dixon Gibbs, of London, demanding a partial annulment of the privilege granted to the two latter, December 27th, 1882, for improvements in the distribution of electricity for the production of light and of motive power, on the grounds of the indefinite character of the description and the want of novelty has been admitted after hearing the accused, and after considering the opinions of experts.

It is held that the plaint, according to the determinations of the Law of the Empire on privileges (of August 15th, 1852) §§ 1, 12 and 29, *a a* and *b b* is established, and the privilege contested as far as the claim 1 is concerned on account of want of novelty, and on account of the claim 2, which runs: "We reserve to ourselves the right to modify the construction as needful," and is consequently imperfect. Hence the claims are declared null and void.

At the same time Lucien Gaulard and John Dixon Gibbs are sentenced to pay the cost of the process (361 florins 73 kreuzer) in equal shares to the Plaintiff, Max Deri, within 14 days.

The want of novelty is based on the consideration that the subject of the contested patent claims was already made public in a series of printed documents prior to December 27th, 1882. The following documents were before that date to be seen in the library of the Imperial and Royal Technical High School of Vienna.

1. The German specification of Paul Jablochkoff, August 14th, 1877, No. 1,630.
2. The English specification of John Henry Johnson, December 24th, 1878, No. 5,257.
3. The English specification of Charles Weightman Harrison, September 2nd, 1878, No. 3,470.
4. The English specification of Charles Tilston Bright, October 22nd, 1878, No. 4,212.
5. The English specification of William Robert Lake, December, 1878, No. 5,183.
6. The work "Description des Machines et Procedés," XIX., 1 section.

## A SYNTHETIC STUDY OF DYNAMO MACHINES.

(*Continued from page* 606, *Vol.* XXV.)

### VII.—PARASITIC CURRENTS—(*continued*).

NOT only must the greatest care be taken in laminating armature cores and keeping their supporting structures out of the magnetic field but to prevent the generation of parasitic currents in the armature conductors themselves suitable precautions must be taken. It has been already stated that in any piece of metal moved in a varying magnetic field E.M.Fs. are induced, and obviously these E.M.Fs. are a source of loss if they cannot be usefully directed, since the currents to which they give rise instead of serving our purpose in the external part of the circuit are wholly expended in heating the metal in which they are generated. The old lecture experiment of rotating a disc of copper between the poles of a magnet until it gets hot, amply illustrates the truth of these observations.

When the angular width of the conductor on the armature is considerable it is necessary to adopt measures for the prevention of parasitic currents. Consider an armature wound with a rather wide conductor: when a length of this occupies a position approximately at right angles to the brushes a certain number of lines of force cut through its flat side, when on the other hand it is opposite a brush the lines cutting it are nought. During the motion, then, a certain number of lines has been subtracted from the flat surface, and an E.M.F. has been generated in consequence. We have seen in previous articles that the same result is arrived at whether we consider E.M.F. as due to a change in the number of lines enclosed by a coil, or due to the separate components of the coil cutting lines of force. Accordingly if lines have been subtracted from the flat surface of the conductor during the motion, one of its edges must have cut more lines than the other. These considerations suggest the most obvious way of reducing parasitic currents, namely, increasing the diameter of the armature and making the pole pieces embrace as wide an arc of the circumference as possible. If this is done without altering the angular width of the conductor, less lines cut through the flat surface and accordingly the parasitic E.M.F. is reduced.

When the conductor is moving under the poles where the field is fairly uniform, the parasitic E.M.F. may be very small. As it leaves the polar tips, however, the field passing through it changes rapidly, and the E.M.F. may be here considerable. Now, the work done in a conductor varies as the product of the square of the E.M.F. and the time during which it lasts, so it follows that in a case in which the variation is sudden the heating due to parasitic currents may be much greater than where the change in the lines is gradual, though the mean E.M.F. over the time is in both instances similar. Another precaution to be adopted for the elimination of parasitic currents lies, then, in shaping the poles so that the change in the field passing through the conductor takes place gradually. This is accomplished by gradually increasing the clearance between the poles and the armature from the crown, where it is made small, to the tips, where it is made greater.

The parasitic currents may be reduced to some extent by dividing the conductors as shown in fig. 139. Here A is the undivided conductor, in which the currents may be assumed to flow in the direction of the

arrows. The surface being continuous, the resistance opposing their flow is extremely small, the currents, of course, being proportionally large. If we put a slit in the conductor, as at B, thus dividing it into two parts, separated from each other—save at the ends which remain connected—we still have the E.M.F. in the same direction, but the current which results is compelled, by reason of the division of the conductor to take a path of comparatively great resistance, and the heat generated is reduced. It is difficult to understand how subdividing the conductor should make any difference to the heating, since, though we have increased the resistance of the path, we have at the same time caused the E.M.Fs. to act summationally along that path.

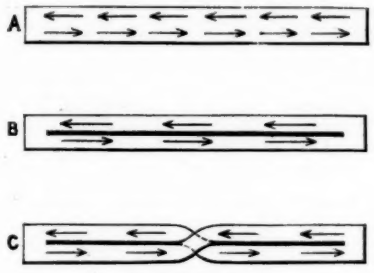


FIG. 139.

There is no doubt, however, that in practice the heat is by these means reduced, and we can only conclude that the sum of all the paths which the currents select for themselves, when the surface remains unbroken, is less proportionally to the E.M.Fs. acting along those paths than when the conductor is divided. When the two divided halves of the conductor are

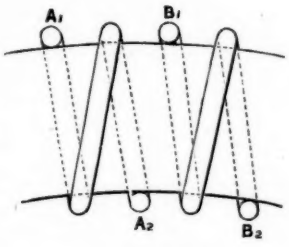


FIG. 140.

crossed over each other, as in Messrs. Crompton's large current machines, the E.M.Fs. in the two divisions, C, fig. 139, annul each other, and the result is a great reduction in the heating. In the actual machines the conductor is formed by two bars, one of which, in middle of its length, dips under the other to crossover it.

In many cases we have to wind wires in parallel to

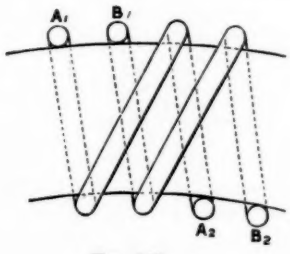


FIG. 141.

form the conductor instead of one heavy wire. Sometimes we can only get on the convolutions we require by winding two or four wires together, while, at other times, the gauge of the single wire which would be required makes the winding less easy than if smaller wires in parallel are employed. When winding in parallel the considerations which have already occupied our attention should be borne in mind. Suppose, for example, we have to wind a Gramme armature, each section having two convolutions of two wires in parallel, one layer deep. We can either wind two turns of one wire first, as $A_1$, $A_2$, fig. 140; then two of the second wire, $B_1$, $B_2$, coupling $A_1$ to $B_1$ and $A_2$ to $B_2$ when connecting up to the commutator, or we can wind both A and B wires together as in fig. 141, $A_1$ and $B_1$ being coupled, also $A_2$ and $B_2$ connected at the other end. We need only look at the two figs. to see that the latter is the correct and the former the incorrect method. In fig. 140 the conductor has double the angular width of that in fig. 141, enclosing in its own width, therefore, double the lines of force, and having, in consequence, considerably greater tendency to heat from parasitic currents. Though the wires are shown apart for convenience, it will be understood that they are in the actual machines wound close together.

*(To be continued.)*

## TESTS ON THE EFFICIENCY OF WESTINGHOUSE CONVERTERS.

By N. MARSHALL.

THE following account of tests made at the Massachusetts Institute of Technology, under the direction of Prof. Charles R. Cross, we believe, will be of general interest to our readers, for, according to the *Electrical World*, these tests were made with great care, and are believed to be quite accurate. They agree to a fraction of a per cent. with tests made on the same converters by different observers and by an entirely independent method. A description of the method employed will be given first, then a description of the apparatus, and the results of the tests will be given finally.

### *Method.*

As all the methods employing electrometers seemed to be very unsatisfactory, a calorimetric method was employed in making these tests, two calorimeters being used, one an ice calorimeter to measure the loss due to conversion and a water calorimeter to measure the output.

When measurements were not being made on the output it was expended on a bank of lamps, adjusted so that the same current would pass through them as through the coils of the water calorimeter; this adjustment was made and maintained by means of a Thomson-Houston current indicator. The change from lamps to calorimeter was effected by means of a commutator and occupied an inappreciable time. Potential was observed by means of a Cardew voltmeter. In making a test the procedure was as follows:—

The converter, stripped of its outside casing, was placed in the inner compartment of the calorimeter, the wire led out and all joints made secure against leakage. The calorimeter proper was then packed with ice, its cover was put in place and ice put around the whole, this ice being contained in a non-conducting box, and serving simply as a jacket. When the packing was complete the apparatus was covered and left to stand over night in order to allow all parts to become thoroughly cooled, and to assume a uniform temperature of 0° Cent. The next morning the rate of drip from the calorimeter was observed, this observation being taken to allow for melting due to the heat of the room. The current was then turned on for eight hours: during this time frequent observations were made on the rate of output, which was maintained as constant as possible. These observations were conducted as follows:—

The temperature and weight of the water in the small calorimeter were noted, the current was then shifted from the lamps to the calorimeter and the time observed to obtain a given rise of temperature, as the current was the same as that through the lamps; these

observations gave a means of computing the output. At the end of the eight hours the current was shut off and the apparatus allowed to stand until the rate of drip was the same as at the start; this was generally for about 48 hours after the current was turned off. When this rate was attained it was assumed that the converter was again at 0° centigrade. The test was then stopped and the water collected from the melted ice and weighed. This gave, after the correction for the atmospheric melting had been applied, a measure of the loss due to conversion. Having the output, we are able to calculate the efficiency.

*Description of the Apparatus.—The Ice Calorimeter.*

The ice calorimeter is made of three separate boxes or compartments.

The outside box is built of 1¼-inch boards lined on the inside with tin, with an intervening space of 3 inches closely packed with sawdust; this box serves merely as a jacket for the calorimeter.

In order that all the water resulting from the melting of the ice may be collected, the sides of the calorimeter box proper are brought to a point, the slope making an angle of about forty-five degrees, terminating in a pipe one-quarter of an inch in diameter. A rubber tube is fitted over this pipe and led through a hole in the bottom of the jacket. To prevent the warm air outside from passing up through into the calorimeter, the tube was allowed to sag and form a U-trap. The tube was furnished with a glass nozzle to facilitate the observation of the drip. The box has a closely fitting galvanised iron cover having two short pipes near the centre through which the leads may be carried. A space of 3½ inches is left between the walls of the jacket and calorimeter, which was packed with ice.

The case which is intended to contain the converter is also of galvanised iron, and is of sufficient dimensions to comfortably contain the converter after it has been stripped of its outside casing. The two supports for this case are of iron rivetted to the sides of the calorimeter, to prevent any possible error from conduction along these. Two pieces of wood are interposed between the supports and the case. A galvanised iron cover, similar to the other, completes the ice calorimeter. A space of about six inches is left between the case and the inside box, which is also packed with ice.

*The Water Calorimeter.*

The water calorimeter is of tin and made in the form of a cylinder and contains a little over 13 kilograms of water. It is placed in a larger tin cylinder with an air space of four inches. The calorimeter rests on blocks of wood to prevent conduction.

The tin used in making the calorimeter is as thin as possible, and the water equivalent is therefore negligible. The wire of the coil is of German silver wound about a wooden frame, the frame itself being held in position by clamps fastened to the sides of the calorimeter. The water was kept in constant circulation by stirring, and the mean temperature was maintained as nearly as possible at the temperature of the room, so that on account of the large amount of water used the cooling temperature correction is about one-tenth of a degree an hour, and is therefore negligible as the tests on this calorimeter were only 10 minutes long. The temperature readings were taken with a very sensitive Centigrade thermometer graduated to tenths of a degree.

*Calibration of the Calorimeter.*

The ice calorimeter was calibrated by placing a German silver coil in the casing and passing a direct current through it; the current and potential were read by means of Thomson's stage* instruments, and were maintained constant. The calibration test lasted eight hours, the current and potential being kept at such values that the number of watts put through the coil should generate the same amount of heat (approximately) as was given out by the converter during the regular test. Two such calibrations were made, and checked the calorimeter to 1 per cent.

The water calorimeter was calibrated by the same method and checked to three-tenths of 1 per cent. Any error in the ice calorimeter from water adhering to the ice was reduced to a minimum by allowing the calorimeter to stand a sufficient length of time before beginning and completing the test.

*Test on Ice Calorimeter.*

March 19th, 1889.

| | |
|---|---|
| Coil of German silver wire, resistance ... ... | 3·11 ohms. |
| Current turned on ... ... ... ... ... | 9 h. 10 m. |
| Current turned off ... ... ... ... ... | 17 h. 10 m. |
| Test stopped, March 21st ... ... ... ... | 12 h. 15 m. |
| Drip at start, drops per minute ... ... ... | 3·8 |
| Drip at finish, drops per minute ... ... ... | 2·7 |
| Weight of ice melted (uncor.) ... ... ... | 17,419 gms. |
| Drip correction ... ... ... ... ... | 269 gms. |
| Weight of ice melted (cor.) ... ... ... ... | 17,150 gms. |
| Heat units developed ... ... ... | 1,372,000 gm. degs. |
| Average potential defl. ... ... | 36·3 P., ¼ N. } H = ·1751 |
| Average current defl. ... ... | 44·3 P., 1 N. } |
| Number of heat units developed, as shown by Thomson's inst's ... ... ... ... | 1,357,776 gm. deg. |

Check to 1 per cent.

A second run gave a check to 2 per cent., but, owing to an accident, was unreliable.

*Calibration of Water Calorimeter.*

March 13th, 1889.

| | |
|---|---|
| Temperature, start ... ... ... ... ... | 9·9 deg. C. |
| Temperature, finish ... ... ... ... ... | 13·6 „ |
| Time run ... ... ... ... ... | 10m |
| Weight of water ... ... ... ... ... | 13,322 gms. |

Thomson Instruments.

| | |
|---|---|
| Potential galv. defl. ... ... ... ... ... | 22·90 P., 1·8 N. |
| Current „ „ ... ... ... ... ... | 29·35 P., 1·2 N. |

Check to 0·3 per cent.

*Test No. 1.*

May 3rd, 1889.

20-ampère Westinghouse converter No. 4.

| | |
|---|---|
| Current turned on ... ... ... ... ... | 9 h. 10 m. |
| Current turned off ... ... ... ... ... | 17 h. 10 m. |
| Test stopped, May 6th ... ... ... ... | 9 h. 5 m. |
| Drip at start, drops per minute ... ... ... | 5 |
| Drip at finish, drops per minute ... ... ... | 1·75 |
| Weight of ice melted (uncor.) ... ... ... | 6,428 gms. |
| Drip correction ... ... ... ... ... | 769 gms. |
| Weight of ice melted (cor.) ... ... ... | 5,659 gms. |
| Calories lost ... ... ... ... ... ... | 452,720 |
| Weight of water in water calorimeter ... ... | 13,656 gms. |
| Time of run in water calorimeter... ... ... | 10 m. |
| Mean rise of temp., water calorimeter ... ... | 10·8 deg. C. |
| Total output in heat units ... ... ... | 7,079,270 gm. degs. |
| Calories per minute ... ... ... ... | 14,748·5 |
| Efficiency ... ... ... ... ... ... | 93·9 |
| Load ... ... ... ... ... ... | 20 ampères, 50 volts. |
| Alternations ... ... ... ... ... ... | 14,530 per min. |

*Test No. 2, May 7th, 1889.*

20-ampère Westinghouse converter No. 4.

| | |
|---|---|
| Current turned on ... ... ... ... ... | 9 h. 10 m. |
| Current turned off ... ... ... ... ... | 17 h. 0 m. |
| Test stopped, May 9th ... ... ... ... | 11 h. 0 m. |
| Drip at start, drops per minute ... ... ... | 3 |
| Drip at finish, drops per minute ... ... ... | 1·5 |
| Weight of ice melted (uncor.) ... ... ... | 6,671 gms. |
| Drip correction ... ... ... ... ... | 354 gms. |
| Weight of ice melted (cor.) ... ... ... | 6,417 gms. |
| Calories lost ... ... ... ... ... ... | 513,360 |
| Weight of water in water calorimeter ... ... | 13,656 gms. |
| Time of run in water calorimeter... ... ... | 10 m. |
| Mean rise of temp. in water calorimeter... ... | 10·7 deg. C. |
| Total output ... ... ... ... ... | 6,867,602 gm. degs. |
| Calories per minute ... ... ... ... ... | 14,611·9 |
| Efficiency ... ... ... ... ... ... | 93 per cent. |
| Load ... ... ... ... ... ... | 25 ampères, 50 volts. |
| Alternations ... ... ... ... ... | 14,840 per minute. |

Memorandum.—During these tests the primaries of converters were in series with two 16-C.P. Sawyer-Man lamps, as the machine was run at a very high voltage for other work.

Note.—Tests were made at the same time of converters of the two other principal manufacturers of alternating apparatus; the next highest efficiency to the Westinghouse was 84 per cent.

* ? static or standard.—EDS. ELEC. REV.

## A NOTE ON A MODERN INSTRUMENT.

Imperious Cæsar dead and turn'd to clay
Might stop a hole to keep the wind away.

A USEFUL occupation; much better than like John Brown's body to be mouldering under ground doing nothing. It shows that Cæsar was made of the right stuff. If in his ashes did not live their wonted fires there was practical material in his dust. It does not seem respectful however to dig up the illustrious dead for such ignoble purposes. But nothing appears to be sacred to the advertiser any more than to the sapper. Listen:—

The Rev. John Wesley has written as follows:—"Electricity cures abundance of diseases, even the most stubborn, many of them in a moment by a single touch, most in a few days, so that this is not only one of the greatest curiosities of the world, but one of the noblest boons God ever gave to man."

Our fathers in their schoolboy days had a distitch commencing,

John Wesley was a good old man
We ne'er shall see him more.

But we do see him again, and are sorry he comes before us in such company. His words are dragged into an advertisement occupying five columns of a recent *Daily Telegraph* announcing the numerous cures effected by the Electropathic Belt and the Gander, we beg pardon, Zander Institute, with oft recurring sensational head-lines such as "Marvellous effect," "Immense good," "A barrister's opinion," "I now think life worth living," "All appliances at tariff prices" (lucky dogs to get them), "Certainly cured my wife" (what a mercy), "Comfort and health," and also "A scientific man's opinion." Our own opinion is not referred to, but we feel no pangs of envy.

What a pity it is that one who so desires the "comfort and health" of his fellows and can afford five columns of a daily does not advertise electric lighting; the public could stand a lot of educating on the subject. The trade could better spare a better man. He might leave many of his head-lines standing, and quote the good and great, ourselves included, in praise of its undoubted benefits.

We have not yet arrived at the new journalism, neither have we insured each purchaser against gas explosions, nor offered a guinea for the best electrical tit-bit, nor an annuity to whoever guessed our bank balance; but we think we really ought to give a prize, say a month's free insertion, for the best advertisement connected with electric lighting and power.

The trumpet is an effective instrument properly played, and in the right place; and a man who blows his own has an affection for it, and brings out its strong points better than an unsympathetic performer. Blow it loud and blow it long, and somebody is sure to hear. Depend upon it it is the music of the future.

## THE KESWICK CENTRAL STATION LIGHTING.

THE electric lighting of Keswick, which was announced as having commenced on the 7th inst., is especially remarkable for the fact that we have here the first central station in this country where water-power is used as the motor. The success attending the application of water at Keswick, which has been found very economical and particularly easy of control, will in all probability be the prelude to its adoption in other places where the difficulty of obtaining a supply is not great.

The central station at Keswick is situated on the River Greta, about ¾-mile above the town, the available fall of water at this point being about 20 feet, which can be slightly increased in case of necessity. The turbine used is a "Victor," giving about 63 H.P.; it is connected with a claw coupling to a countershaft, from which is driven the dynamo. The dynamo employed is a Kapp 30-unit alternator, made by Messrs. Johnson and Phillips; it was tested before being delivered very much above its full load, and has proved to be in every way an excellent machine.

A Westinghouse engine, fed by a Hyde duplex boiler, is also arranged to drive on to the countershaft, in case from any shortness of water, or other cause, the turbine should have to be stopped. The pulley driven by the engine, and that driving the dynamo on the countershaft, are provided with friction clutches, to enable either engine or turbine (or in the case of an additional dynamo being added) either dynamo to be stopped or started at will.

Provision has been made by the engineers to the undertaking for the addition of another 30 unit alternator and turbine, and we understand that it seems probable that they will have to be added almost at once, as already the demand for the light is such that the company is unable to take on more consumers.

The pressure used in the mains is 2,000 volts, reduced to 100 volts in the secondary circuits. The mains, which are of a special insulation, are carried overhead, on Johnson and Phillips "fluid" insulators. A special arrangement, designed by Mr. Edward Cowan, one of the company's engineers, is in use for preventing any surface leakage of high tension current from entering the houses. The insulation resistance of the mains is very high. The station has proved itself a great success, and reflects special credit upon the company's engineers, Messrs. W. P. James Fawcus and Edward W. Cowan, of Chester, who have found the selection of water power to thoroughly justify their recommendations, for the ease and facility of regulation is very remarkable, the turbine also having proved itself a most satisfactory and steady motor.

## COAD'S PATENT SINGLE FLUID PRIMARY BATTERY AND FITTINGS.

THE inventions of Mr. Coad, which we have recently had the opportunity of examining, consist of four patents covering improvements in electric mining lamps, an incandescent lamp holder, a galvanic battery, and a special form of lens for projecting the light from an incandescent lamp.

Messrs. Jensen and Son, having made searches among previous patent specifications, report favourably on the validity of the patents, which were all applied for in the course of the year 1888.

The battery as manufactured is a single fluid cell, and consists of a carbon and zinc couple excited by a fluid—of course a secret one—of the bichromate type; the sulphuric acid usually mixed with the solution is, we understand, replaced by some other acid, doubtless nitric. It is questionable whether, even in the event of a very large demand sprnging up for this battery, the component parts of the fluid will be divulged to the users, the inventor, apparently, leaning to the idea of supplying the public with the exciting fluid in a manner similar to that in which it now obtains paraffin oil, so that the fluid may be purchased at any oil shop for the sum of 10d. to 1s. a gallon. In fixing the electrodes no screws, bolts or nuts are used, the plates resting against platinum contact wires projecting from the sides of the cell, the electrical contact of the plates with these wires being secured by plugs or wedges of hard rubber pressed down between the electrodes; the lid of the battery is made watertight in the same way as the ordinary travelling photographic bath, and keeps these wedges from accidentally slipping up and releasing the pressure. The electromotive force of these cells on open circuit was by trial with a five cell battery, 2 volts each or 10 volts for the five. This current being closed through a small lamp of 2·5 candle-power worked the lamp efficiently at a potential of just about

9 volts. It is stated that one charge will last for 12 hours at a cost of about one penny, but it is admitted that the battery should be used as soon as charged, for unless the pattern be of the tipping sort there will be loss whilst it is standing idle.

Patent No. 4,221, of 1888, applies to a lamp-holder, or portion of the holder, which serves to keep a pressure on the spring contact hooks forming the connection with the platinum loops on the lamps, and also to steady and centralise the lamp. The device consists of an arm screwed to the body of the lamp-holder, having on its upper end a ring at right angles to the arm to slip over the small part or stem of the lamp. The novelty is comprised in a slot cut in length of the arm, whereby the arrangement can be raised or lowered to suit various patterns of lamp bulbs.

Patent No. 7,695, of 1888, covers a peculiar formation of lens with flat facets—12 in number preferred—meeting in a point, in appearance something like the outside of an open umbrella, but more pointed. This lens is stated to be highly effective, especially when the base is made slightly convex. As evidence of its suitability for its purpose a test, by Messrs. Alexander Wright & Co., is adduced, *proving that a lamp of* 10 *candle-power has, by means of this lens, produced a light equal to* 200 *candles.* The italics are ours.

Patent No. 7,696, of 1888, is for a portable or miner's lamp, suitable for use in mines where gas is prevalent, or in any place where inflammable material is stored, or the atmosphere is charged with minute dust, which sometimes takes fire when coming in contact with a bare light. The feature of this lamp is a device or means for automatically breaking the electric circuit in case of breakage of the glass bulb within which the filament is enclosed; to accomplish this the chamber in which the lamp is placed is filled with compressed air by the aid of a hand-pump when the battery is charged. This compression of the air forces a diaphragm backwards and makes the contact between the lamp and the cells; this contact itself is in a protected chamber. In case of the glass lens and bulb of lamp being broken the escape of the air releases the contact and extinguishes the lamp before the gas can be exploded. The weight of a small lamp, complete, with every improvement, is between 4½ to 5 lbs.

Mr. J. E. H. Gordon, in his report on Coad's primary battery and safety lamp, endorses all that has been said above, and adds that the battery is simple and very easily manipulated, and during the whole of his experiments it had been charged and recharged by the office boy and not by the proverbial and accomplished domestic servant, and that the duty was not attended with any difficulty.

We were not aware that Mr. Coad hailed from the sacred island

> Whose sons, unaccustomed to rebel commotion,
> Though joyous, are sober, though peaceful are brave,

but we cannot avoid having some doubt on the matter upon reading the following recommendation for the general use of his battery:—"The absence of noxious fumes or *inodorous smells* from the battery renders its adoption for ladies' boudoirs, &c., invaluable."

The commercial success of the Coad battery will not, however, depend upon its adaptability to purposes of luxury, but upon whether the statements regarding its cost for working can be verified after a longer experience than the few laboratory tests already made, and also whether the stated ease in charging and cleaning will be borne out in the ordinary wear and tear of every-day use.

We could point to half a dozen batteries which will do everything that the Coad cell will accomplish, and to one at least which is its superior. How people can possibly expect a galvanic couple in a space which will hold scarcely any liquid, to be lasting in its operations, if the current given is to be of any practical use, is beyond our ken. Zinc will consume slowly or rapidly, and liquids will become spent sooner or later as the work done is great or small, and the time in which a battery becomes practically useless depends in a great measure upon the bulk of the solutions. We utterly fail to see in Mr. Coad's inventions anything which places them in advance of many similar devices of the past.

## J. G. STATTER & CO., LIMITED.

OF the principal improvements in this firm's manufactures made during the year 1889, the following may be noticed:—

For large machines for low and moderate tension they have adopted the single circuit field magnet made entirely of wrought iron machined all over.

These machines are provided with drum armatures and are ventilated, and they have been very successful in point of freedom from heating, smooth running at the commutator and high commercial efficiency.

For constant current and for high tension machines, Messrs. Statter & Co. have adopted the double circuit field magnet and the sectional ring armature (Joel's patent). They have built a great many machines of this pattern during the past four years, and find the type admirably adapted for high tension work.

The above types of machine will be stock patterns for the future.

During the past year they have constructed a pair of D.R. size (37½ units each), and we believe that the great utility of constant current machines is gradually becoming recognised, and that a great number will be required during the present year.

A combined engine and dynamo, consisting of a high speed open type engine belted to a standard type dynamo by leather link belt and tightened in by a setting in pulley, and the whole mounted on a box bed plate of cast iron, has been successfully introduced during the past year and many have been sold and are in successful operation.

A great amount of time during the last year was devoted to the perfection of machinery for the transmission of power and for telpherage and light railways. Eleven electric locomotives for telpher lines have been constructed, some of these having a tractive force of 1,500 lbs. on the draw bar.

In alternating machinery the firm has made considerable improvements. The transformers used for the lighting of Chelmsford by Messrs. Crompton and Co., Limited, are Messrs. Statter's patents and were made by them, and Messrs. Crompton have been supplied with some additional ones for their installation at the Barry Docks. The West Drayton firm has also taken up the manufacture of alternators for central station lighting, and has now several in hand for an important central station.

**Latest in Electrocution.**—An experiment was lately made with the apparatus for electrical execution at Chatham (U.S.) prison in the presence of the State Commission, and under the direction of Mr. Harold P. Brown, the New York electrical engineer. A steer, weighing 450 lbs., was first experimented on. Two wires leading from the dynamo were attached to the body, one on the head, and the other on the right flank. At the end of each wire was a water-soaked sponge. At a given signal Mr. Brown turned on a 900-volt current, and at the same instant the animal dropped dead without a struggle or a groan. There was no lapse of time between the time the current was turned on and the animal's evidently painless death. Further tests without the Westinghouse dynamo and alternating current were also satisfactory. For the execution an electrode, covered with a wet sponge, will be placed on the top of the condemned person's head, and another, in a large shoe, on one of his feet. His arms will then be strapped across his breast, and a similar strap placed around his ankles. He will then be placed on the chair, and the straps will be attached to hooks provided for the purpose. A button will be touched, and then all will be over.

## ELECTRIC LIGHT AT THE PUBLIC RECORD OFFICE.

THIS fine building in Fetter Lane, containing the historical and legal records of the United Kingdom, has recently been fitted up with the electric light in the principal rooms and corridors; in all, 104 16-C.P. incandescence lamps, by Messrs. Henry F. Joel & Co., of Wilson Street, Finsbury, London.

The E.M.F. of the current is 50 volts, and it is supplied from the Metropolitan Supply Company's station in Sardinia Street, at a pressure on the primary of about 1,000 volts.

The lamps are divided into four distinct and separate circuits, corresponding as nearly as possible to four of the sections or departments of the building, each circuit having a separate Westinghouse arrester, main switch, and two double-pole fuses, so that there are practically four distinct installations; this dividing of the current being a very wise feature in the arrangements for lighting so important a building, containing, as it does, records of priceless value.

The entrance, corridors, and staircases are on one circuit, with pendant lamps specially fitted in the apex of the stone arches in the staircase. In the principal library, known as the "Round Room," there are 30 lamps, and the design of the special fittings, and the effect of the light, is much admired; there are 64 light pendant electroliers suspended from an upper gallery by ornamental wrought iron swinging brackets, to enable the lamps to be drawn in close to the galleries for dusting, &c.; these are fitted on two circuits, controlled by one switch. The central table is fitted with a massive 6-light standard electrolier.

In the legal room there are 18 single suspension lamps, in three rows of six each, fixed to the casings and blocks, and supported by iron clips on the ceiling girders; these are divided into two circuits, controlled by two switches. In the adjoining room, where the "Doomsday Book" is exhibited, a 3-light electrolier is fixed to the girders in the centre of the room.

In the Government search-room there are eight single suspension lamps on one switch, and in the offices and record store rooms there are groups of two, three, and five lamps.

The work has been of an exceptionally difficult nature, owing to the building being entirely made, inside as well as outside, of stone, brick, iron, and slate; all the walls have had to be plugged, and the iron girders and partitions tapped to afford fixing for the casings and wires, and in many cases special clamps have been contrived for supporting the lamps. The necessity of perfect insulation has made extra precautions necessary. The whole of the casings are painted inside and outside with a waterproof lead paint, and the insides are finally painted with asbestos fireproof paint. All the joints are varnished with rubber varnish after being most carefully insulated, and the casings, where they pass through the walls, are also varnished over the paint. Silvertown cable of 300 megohms insulation has been used everywhere. The casings are fixed in tight and have been neatly fitted to follow the curves of the arches. All the mains, sub-mains, and single wire and lamps, are protected by porcelain fuses, mounted on varnished wood blocks, the single pendants are also fused in the porcelain ceiling roses, all the lamps are fused four times between them and the converters. A special flexible cord of 300 megohms insulation has been used for the suspension lamps.

The circuits when recently tested gave an insulation resistance of over five megohms, including all lamp points, fixing, &c.

The main switches are of the Joel type, with glass fronts and special keys to each, and (left in the charge of the managers of the rooms). The lamp holders are also special, same as supplied to the Law Courts.

The great care exercised by the authorities when planning the position of the lamps has tended to make the result the great success it is, indeed; the rooms and passages which were formerly so gloomy, are now rendered quite cheerful in appearance. The light is undoubtedly a great boon to the many habitual frequenters and attendants in the building, and also to the many ladies who are employed to translate and copy the old deeds.

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**Water Power.**—The successful working of the Central Station at Keswick by means of water power should bring a considerable amount of attention to this method of obtaining power. There can be no question but that there are many places which do not require a very large amount of light, and where coal is expensive, which could very readily be supplied by means of water power close at hand. The economy of working is great, and the ease of regulation is known, and the only danger to be feared is the scarcity of supply from exceptional drought. This has been met with at Keswick by the addition of steam power as an alternative. Electric lighting by means of water power is well known, but this is, we believe, the very first application of it to the purposes of a central station in this country. The first instance of a private installation was, we believe, at Sir William Armstrong's house, where water was used. But perhaps the best known is that at Hatfield, where a varied amount of work is done on the Marquis of Salisbury's estate.

## NOTES.

**County Council and the Electric Lighting Schemes.**—At the weekly meeting of the County Council on Tuesday last the Highways Committee reported that they had considered the provisional orders, 23 in number, for which application had been made to the Board of Trade, and the three Bills to be introduced into Parliament next session, relating to electric lighting schemes, and had received reports from the solicitor and Mr. Gunyon, of the engineer's department, thereon. They recommended, amongst other things, that all the provisional orders and Bills should be amended so as to make them accord with the legislation in respect of electric lighting; that provisional orders and Bills, comprising areas for which Parliamentary powers had already been conferred upon more than one company, be opposed; that in respect of provisional orders and Bills relating to the City, the Council should seek for the same powers as were conferred upon it by the orders and Act of last year, none of which affected the City; that in addition to the above general recommendations, the following orders and Bills, which relate to the Strand district and the parishes of St. Martin-in-the-Fields and St. Pancras, be objected to:—St. Martin-in-the-Fields and Strand Electric Supply Order, Strand Electric Lighting Bill, St. Martin-in-the-Fields Electric Lighting Bill, St. Pancras Electric Light Supply Order. This was agreed to.

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**The Electric Light in Brussels.**—The municipal authorities of the City of Brussels have decided not to grant to the German companies the concessions asked for by them under cover of a firm which has just been turned into a company. They have also come to no decision in favour of one of the local companies which had submitted their tenders—that is, the Electrique Company and that of M. Van Rysselbergh. The latter gentleman was announced to lecture on Friday evening last on his scheme before the Belgian Engineers' Society. This lecture was to be followed by a discussion.

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**Affairs in Brazil.**—Despatches received at New York, on Saturday last, announce that Baron Capanema, the chief of the telegraph department of Brazil, has been arrested at Rio de Janeiro on a charge of being deficient in the sum of 90,000 pesos in his accounts.

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**Bolton Town Council and Electric Lighting.**—At a special meeting of the Bolton Town Council, held on Saturday, it was unanimously resolved to oppose the Bill introduced by the Lancashire and Cheshire House-to-House Electric Lighting Company, to supply the electric light within the borough. A further resolution authorises the Corportion to seek the necessary powers to supply electric light wherever there was a demand for it.

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**The Lighting of the British Museum.**—A private view of the lighting of the galleries of the British Museum took place on Tuesday night, the arrangements of which were described in a recent issue. A large number of visitors responded to the invitation, and from every point of view the preliminary trial was a great success.

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**The Post Office Cable Ship.**—H.M.T.S.S. *Monarch* left her moorings off Charlton, on January 13th, and we learn that on January 24th, she had only succeeded in reaching Falmouth, having been delayed in her voyage to the Hebrides, by the extraordinarily bad weather which has been experienced round our coast. We are further informed that several of the staff and crew have been obliged to leave the ship, owing to severe attacks of the influenza.

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**San Francisco to Hong Kong.**—It takes about 15 minutes to send a message from San Francisco to Hong Kong, *viâ* New York, Canso, Penzance, Aden, Bombay, Madras, Penang, and Singapore.

**C. J. Kintner on the Electric Light Questions.**—Mr. Kintner, the well-known American patent expert, gives it as his opinion that American engineers might obtain much valuable information from their slow-going English cousins, who, if they have not made rapid strides in the introduction of electric lighting plants, have at least been very certain of their ground. During the long discussion in America, which has lasted for more than a year, very little reference has been made to the progress in Europe. In London accidents from electricity are very rare, and the statutes governing the distribution of electric currents are based upon common sense ideas. The greatest care has to be observed in locating the conductors, the insulation has to be of the most perfect character and every detail of construction has to be carried out with a rigid regard for the public safety; for these reasons the alternating system, as the more economical, is practically the most prominent and more used than its rivals. So far good, but when Mr. Kintner comes to details he shows considerable ignorance of accomplished facts as published in the scientific press; or, perhaps, what is more probable (being an advocate for the concentric form of conductor), he has been carefully misinformed as to the results of experience in England. Mr. Ferranti is credited with having achieved the feat—which, if it were only a matter of fact, would doubtless relieve that gentleman's mind from much racking anxiety—of sending his primary current, for the past year, over a line eight miles in length, at a potential of 10,000 volts at present. The safety of this system having been endorsed by Sir William Thomson, electrical engineers can, therefore, confidently recommend the construction and use of cables made on the concentric principle. There is another statement, that will be news to the House-to-House Supply Company, to the effect that the galvanic action between the lead of cables covered with that metal and the iron conduits in which the cables are placed, rapidly destroys the iron as well as generates gases likely to cause explosions. The New York expert, however, pens a bit of sound advice, which could be practised with advantage in every country, viz., that a municipal or public authority when it requires information on electrical subjects should employ some practical electrical engineer who is known to be unconnected with any supply company, and consequently free to form an independent and genuine opinion.

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**The National Telephone System.**—The connection of this company's northern system, by the line in progress between Birmingham and London, with the metropolitan branches, will result in a very important development of the telephone service. The line referred to was commenced about two years ago, and only lacks completion by a break of a few miles near London. The length of this new line is about 140 miles, and the delay in putting it through has been chiefly due to the difficulties of obtaining way-leaves. The experiments carried out recently at Edgware before the Hendon Local Board gave every satisfaction, the speaking being perfectly clear and distinct. The National Telephone Company have at present provincial centres at Bradford, Leeds, Sheffield, Nottingham, Birmingham, Liverpool, Manchester, Blackburn, Burton, and Kidderminster; these, with the 120 sub-centres associated with them, will, by the new line, be connected in a speaking circuit with London. When this is completed, the company intends to connect their provincial centres at Glasgow, Edinburgh, Kirkcaldy and Dundee, with the rest of the National system.

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**Destructive Cyclone in New York.**—Serious damage was recently done to the telephone systems of Buffalo and Rochester, New York, by a cyclone. The telegraph wires were also blown down. The long-distance telephoning between these two cities and New York was stopped, and all telegraphing ceased.

**Cable Repairs.**—It is rumoured that the section of the Commercial Cable Company's system, connecting Waterville with Havre, is broken or faulty in two places. The *Mackay-Bennett* is now engaged in effecting the repairs to this section. On the other hand, it is reported that the faulty cable is the section between Porcella Cove and Brest, belonging to the French Atlantic Company. At the same time, we are informed that one of the Anglo Company's cables is broken some 8 miles off the Irish Coast, and that the *Britannia* has been sent out to undertake the work of repairing. Given fine weather, the job should not occupy much time, since the depth at this distance from land does not exceed 40 to 50 fathoms. The *Britannia* left the river on Saturday, the 25th January. We learn that the *Faraday* is shortly to leave the Thames for repairing the Jay-Gould Atlantic cable, which still remains broken down. It is said that these repairs will be effected in very deep water. It will be remembered that the *Faraday*, during her last voyage, repaired the other Jay-Gould section, both having broken down much about the same time.

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**Electrical Railway Speed.**—The fastest time made by an electrical railway is, according to the *Age of Steel*, a mile a minute by a small experimental car. On a street railway system 20 miles an hour is the fastest.

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**Phonographing Chimes.**—Impressions of Grace Church (New York) chimes were taken on New Year's Eve by phonograph, and afterwards transmitted by telephone a distance of two miles. We pity these poor mortals who had to listen to the reproduction.

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**The New Chief of the French Posts and Telegraphs.**—M. Selves, who has replaced M. Coulon, as head of the department of posts and telegraphs, is a comparatively young man for the important position he has been called upon to assume, being born in 1848. He was educated for the bar, and on receiving his degrees, gave early proof of the possession of remarkable oratorical powers, to which is probably in a great measure due his rapid advancement. He was appointed Prefect of Tarn-et-Garonne in 1880; in 1881, he was created Chevalier of the Legion of Honour; in 1882, he became Prefect of the Oise; in April, 1885, he was given the Prefectship of Meurthe-et-Moselle, and in September of the same year he was appointed Prefect of the Gironde; in December, 1885, he was advanced to the grade of officer of the Legion of Honour. M. Selves has the reputation of being a most able administrator, an indefatigable worker, and of possessing in a marked degree that suavity of manner and control of personal sentiment so necessary in official intercourse.

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**That Secret Battery Fluid.**—There is nothing very new in carbon and zinc, and we could wish there was no mystery about Mr. Coad's electrolyte. Mysteries are things that rarely bear investigation, and daylight has a dissipating effect on them. There are, however, many who now hold that a trade secret is better than a patent. We hope for the sake of the inventor and his customers that this may be a case in point, for there is plenty of room for a better primary battery than has hitherto been produced, and we welcome any improvement in anything electrical.

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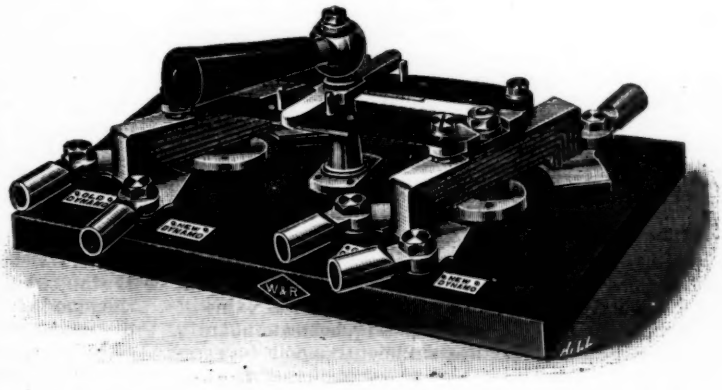
**Electrical Novelties and Sandwiches.**—A correspondent who was present at Mr. Coad's Exhibition writes as follows:—"Not the least interesting counter to the visitors on Saturday was that which supported plates of light refreshments accompanied by appropriate but not secret liquids. We have often noticed what seems to be a natural affinity between electrical novelties and sandwiches. They are neither of them always of much account, but on this occasion I can speak, at any rate, for the sandwiches. They were varied, and of excellent construction. Let us hope the batteries will live up to them."

**Interchange of Useful Information.**—Mr. Crompton, at a meeting of the Electrical Trades Section of the London Chamber of Commerce on Monday last, considered that a most important object to be attained in the electrical trades was the interchange of useful information. Many trades had thus benefited largely, notably the iron and steel trades, in bringing the Bessemer process to a successful issue. Comparing figures in the cost of working central stations would be a great advantage, other than those supplied to the demand of the Board of Trade. Many companies would, no doubt, refuse to do this, but he knew others would fall in with the scheme. This has a great deal to recommend it, and though some may sneer, we see no reason why such a principle should meet with great objection. Comparing one's coal bill with our neighbour's, might teach economy and lead us to enquire if there was waste, thus enabling one to effect a saving. Then there is the question of the cost of distribution, which to suppliers of electric current is a most important item. The best way of meeting with success in this line would be for a temporary association to be formed, in which firms might become members on complying with certain conditions, which, in our opinion, need not be hard. It might at first be a small one, but the results would be so useful that before long it would have grown into a large and powerful organisation.

**Double Pole Two-Way Switch.**—Our illustration shows a new form of Woodhouse and Rawson double pole two-way switch, which is likely to find favour with those who advocate the double pole arrangement of switches, and its construction contains one or two interesting novelties. It will be seen that the brushes are built up in a somewhat different way to the well-known multiple brush hitherto employed in switches of Woodhouse and Rawson, they are given a still greater individuality of movement by separating each part from the adjacent one by a washer in the centre, and for simplicity of construction they are made with square corners in place of round. The crossbars which connect the two brushes are of vulcanite which possesses sufficient strength and the necessary elasticity and insulating properties. The method of attachment for the cables is the very convenient movable socket form into which the cable is sweated.




**The Stock Exchange and Messages.**—We are informed that the managers of the Stock Exchange have arranged with the Boy Messengers' Company for a special service of messengers in connection with the "House." A system of electric signals has been constructed under the direction of the Hon. Patrick Bowes Lyon, of the Boy Messengers' Company, by means of which each station—Capel Court, Shorter's Court, and New Court —will be connected with the company's City depôt.

**Another Birmingham Award.**—We are informed by Messrs. Ruston, Proctor & Co., of Lincoln, that they have just received from the late Exhibition, at Birmingham, the intimation that they have been awarded a "Special First Class Gold Medal" for the compound fixed engine of medium stroke (Class M in their catalogue), which they had at work in connection with the electric lighting of the buildings.

**Standard Wiring Table.**—At a recent meeting of the American Institute of Electrical Engineers, a committee was appointed to formulate for approval a standard wiring table for lighting and power purposes. It is not, we understand, intended to make any radical departure from the best practice of the day, but rather to establish a table which shall be generally recognised and used as a standard.

**Office Novelties.**—We have received from Messrs. Woodhouse and Rawson a sample of the celluloid paper knives which they are distributing as a gift to their numerous clients. The blade is worked off on one side into inches and centimetres, and on the other side is a calendar for 1890, the whole of the lettering being gilt. It is an excellent specimen of the successful imitation of ivory. We have also been favoured by the same company with an office calendar for the present year, the minor details of which appear to have been specially designed for such of their friends as have exceptionally good eyesight.

**The Central London Railway.**—At the weekly meeting of the Birkbeck Debating Society on Monday night Mr. J. Trenner opened a debate on the above subject. The speaker clearly showed the advantages resulting from such a scheme, and proposed a resolution to the effect that reconstruction of the railway was most desirable, which was adopted with one dissentient.

**Electricity as an Employer.**—It is estimated that over 250,000 persons in the United States are engaged in business depending solely on electricity.

**Shallenberger Meters.**—Over 11,000 of the Shallenberger electric meters are now in use in the United States. How many of any type are used in England?

**The Ohm Memorial.**—The subscriptions towards raising a memorial to Ohm in Munich now amount to about £1,200.

**Telephones in the United States.**—There are about 300,000 telephones in use in the United States, and more than 170,000 miles of telephone wire in operation, over which 1,055,000 messages are sent daily.

**What is It?**—We understand that another important amalgamation of electric light and power interests on a gigantic scale will shortly take place; but we are at present unable to give any details of the combination.

**Accident at Sardinia Street.**—On Wednesday morning people living at the west side of Lincoln's Inn Fields were thrown into a state of consternation by a loud report coming from the central station works of the Metropolitan Electric Supply Company in Sardinia Street. As far as can be ascertained, a pipe of one of the boilers had burst. The severity of the explosion may be gathered from the fact that two large wooden doors parting Sardinia Place were blown out, and part of the roof was destroyed, besides other damage to the premises. One man at least was injured and taken to King's College Hospital.

**Electrical Operatives Note.**—A meeting of the Amalgamated Union of Electrical Operatives will be held at the Pauls Head, Finsbury, on Saturday night, at 7.30, to further proceed with the rules and elect officers for the year.

**Electricity on Liverpool Tramways.**—At the half-yearly meeting of the shareholders of the Liverpool United Tramways and Omnibus Company which was held on Saturday, Sir David Radcliffe, chairman, in the course of his remarks, said that arrangements were being made for experiments with the view of the introduction of electric cars to the system, and said the time was not far distant when the company would be in possession of an electric engine, which would be tried on its merits. The report and accounts, after a long discussion, in the course of which the directors were heartily congratulated on the working of the company for the six months, were adopted, and the retiring directors re-elected, the proceedings closing with a vote thanks to the chairman.

**St. Helens in Darkness.**—At eight o'clock on Friday night St. Helens was suddenly plunged into darkness. All the lamps, public and private, were extinguished, and crowds of people flocked into the streets terrified. A ball at the Town Hall and a meeting at the Engineers' Hall were interrupted, and serious inconvenience was occasioned at several important works. At the railway station the lamps and signals went out, causing a block for some time. Gas was supplied a few minutes later. The mishap arose in charging the holders at the Corporation Gasworks.

**"Electricity in the Service of Man."**—A lecture on this subject was recently delivered before the Plymouth Mechanics' Institute by Mr. W. Lant Carpenter, Manager of the School of Electric Engineering. Dealing with the subject of electric lighting, Mr. Carpenter advised those desirous of adopting the new illuminant, not to wait in the hope of getting improved dynamos. He believed, however, that there would probably be an improvement in lamps.

**Electricity in the Treatment of Metalliferous Ores.**—According to the *Mining Journal* success has already attended the electrical process, which has been adopted in South Australia, for the recovery of the minute gold dust that has hitherto been lost in the work of separating the metal from the ore. The economical value of the process has, says our contemporary, been abundantly proved, and the returns are sufficiently good to compensate for the somewhat high expense of the process.

**Electric Lighting in Places of Worship.**—Though this is comparatively a new development, it should become exceedingly popular. Already there are a few which boast of installations; and a denominational chapel in the West Central District makes special announcements to its congregation that henceforth it will be lighted by electricity. The Chapel Royal is closed for the present for the purpose of making arrangements for the lighting of the ancient building, and doubtless others will speedily follow. It is not many years ago since many parish churches were lighted with the flickering flame of a candle. The appearance of gas was a great improvement, but left a great deal to be desired. In churches with pretences to artistic work, one could see the injurious effects of gas, many valuable paintings being discoloured, and ceilings blackened. Electric light to a great extent will remedy many evils, and we should imagine that country churches in which gas has not yet penetrated, might with advantage adopt the electric light, especially if the vicarage and other large houses were in close proximity.

**Society of Arts.**—The second lecture of the Cantor series, on the "Electro-magnet," by Dr. Silvanus P. Thompson, was delivered last Monday; and the third will be on Monday, February 3rd. The subjects will be special designs, various forms and their uses; electro-magnets for quickest action, for longest range, for maximum traction, for minimum weight, for alternate currents, for series work, and for parallel work, will be given.

**Electric Railways.**—There is a very good article in last week's *Engineer* on this topic, and it is worth the perusal of those enthusiasts who believe that the time is at hand when railways proper—in contradistinction to tram lines—will be operated by electrical energy. The advocates of electrical traction suggest very high speeds, but this means great power, and nothing less than 500 H.P. must be thought for an ordinary express train. It is also a mistake to imagine that the motors or electric locomotives can be made extremely light; weight must be provided for adhesion, and it is unlikely that less than 30 tons would suffice. The *Engineer* thinks that it is quite improbable that anything will ever lead to the substitution of electricity for steam on our great English railways, and in this we decidedly agree. On the underground system, however, our contemporary would welcome the application of electric locomotion. We cordially commend the paper from which we quote to the notice of everybody interested in this very important subject.

**Electric Welding.**—During the last two years frequent reference has been made in our columns to the process of electric welding, invented by Professor Elihu Thomson. The principle involved, and the apparatus employed at that date were described and illustrated in our issue of January, 6th, 1888, and in our publication of November 16th of the same year, a report was given of the remarks made by the inventor on the occasion of his showing improved forms of the machines at the Franklin Institute. Since that date, a company has been formed in Boston, U.S., for the manufacture of welding apparatus, and it is stated that the process is now in daily use for various manufacturing purposes, and likely to become of the greatest value to the metal interests of the world. It is now intended to commence making the machines in this country, and in order to bring them to the notice of the representatives of the press and others, a demonstration was given recently, at Fanshawe Street, Hoxton, of the variety of uses to which the process of electric welding can be applied. Mr. W. C. Fish, of Boston, who had charge of the machinery, illustrated the mode of welding bars and tubes of various diameters, of making joints at angles with bars, and of welding rings or hoops, the simplicity of the operation and the perfection of the weld being clearly proved. Among the advantages claimed for the process, as compared with present practice, are the homogeneous nature of the welding, the absolute control of the heat which is applied to the metal in sight of the operator (not covered by coal or hidden by flame as in the ordinary process) rapidity, cleanliness, and economy in labour, time and material. The operator of the welding machine needs no knowledge of electrical laws, nor need specially-skilled labour be employed; and since the welding current is of extremely low pressure, there is absolutely no danger and the machinery may be freely handled with impunity. In addition to welding, it may be of interest to mention that electric riveting also is found to be a perfectly practicable process, having already been accomplished on a small scale. The cold rivet is placed in the rivet-hole and electrically heated to the proper temperature. While in this condition, the rivet is closed by any ordinary steam or hydraulic or other mechanical apparatus. The heating of a half-inch rivet, of two or three inches in length, occupies about 20 seconds.

**Tailoring by Electricity.**—A tailoring firm of Minneapolis, U.S.A., makes use of electricity for running the shears, cutting purposes, and for warming the pressing irons, as well as for lighting the shop and factory.

**The Value of the Ohm.**—Recent experiments, according to Lippmann's method, give the value of the ohm as equal to the resistance of a column of mercury at 0° C., one square mm. cross section, and 106·27 centimetres long.

**Electric Tramway.**—An electric tramway has just been opened between Clermont Ferrand and Royat, two well-known holiday resorts, about 7 kilometres apart. The installation consists of a Farcot steam engine of 150 H.P., and a six pole Thury dynamo of 300 volts and 350 ampères. A small 24 H.P. steam engine and dynamo is used to excite the larger dynamo and to supply the station with electric light. The current is supplied to the motors on the cars by means of an overhead wire, and the return current passes along the rail. The speed of the cars is 12 kilometres per hour.

**Leeds Town Council and the Electric Light.**—On Tuesday, a resolution was passed refusing consent to the granting, by the Board of Trade, of provisional orders, which have been applied for by companies. The Electric Lighting Committee were also instructed to report, in two months, upon the question, with full information upon all improvements which have been made in the meantime.

**A Canadian Carbon Factory.**—The Municipality of Peterborough, Canada, has granted a loan for the erection and maintenance of a carbon factory.

**Phonographic Dolls.**—The Edison Phonograph Works, at Orange, N.J., are engaged in making 50,000 dolls, all of which are to have phonographs placed in their little "in'ards."

**The Rubicon Crossed.**—The following extract is from the half-yearly report of the North Metropolitan Tramway Company, to be submitted to their shareholders on the 5th day of February, 1890:—"As mentioned in a previous report, an arrangement was entered into with the Electric Traction Company for working the company's cars on the Barking Road section, and the directors are glad to state that the results during the half-year have been satisfactory. The electric cars have run 34,366 miles, and have carried 469,095 passengers. The cost to this company for electric traction has been 4½d. per mile run (including the wages of drivers), which is less than the average cost per mile run for horse traction over the entire system. The Barking Road section is a short single line with loops, requiring only a low mileage, with a small number of cars, which does not offer such facilities for economic working as a longer line would, with a higher mileage, and more cars worked by a larger installation; but the result of the working of electric cars on the Barking Road justifies the directors in hoping that Parliament will sanction the introduction of electric power over the company's system, and enable them to extend its application to other lines." Such a reference to the work of the cars on the Barking Road is very gratifying and encouraging for the future of electric traction generally.

**A Proposed Grant for Experiments.**—The United States Congress is to be asked to appropriate $250,000 to pay the cost of experiments to test the utility of electric motors as applied to the steering, lighting, and ventilating of naval vessels, as well as to pumping and hoisting, and the handling of marine ordnance and ammunition; and generally to testing the efficiency of electrical power as applied to marine architecture. The Bill particularly mentions the Sprague system of motors.

**The Electric Light in South Wales.**—The Electric Trust Company have, it is understood, decided not to proceed with their applications for the two provisional orders for the electric lighting of the municipal borough of Cardiff and the borough of Newport, together with the Alexandria Dock. The abandonment of these proposed orders leaves two orders now deposited with the Board of Trade for the electric lighting of Cardiff, namely, one by the Brush Electrical Engineering Company, and the other by the Western House-to-House Electricity Company.

**Electric Lighting at Woking.**—The authorities here seem quite undecided as to what action to take with reference to electric lighting. Messrs. Bircham & Co. gave notice to the Rural Sanitary Authority of their intention to apply to the Board of Trade, on behalf of the Woking Electric Company, for a provisional order for the storage and supply of electricity. The Authority then asked the Parochial Committee to give their opinion on the subject, and the latter body have expressed their conviction that overhead wires ought not to be allowed on any pretext, and that the company ought not to be allowed to interfere, in laying down their wires, with any of the present drainage or water pipes that they might encounter. These opinions were sent to the Authority, with the request that the latter would further consider the question.

## NEW COMPANIES REGISTERED.

**Norwich Electricity Company, Limited.**—Capital, £50,000 in £10 shares. Objects: To carry on, at Norwich and elsewhere, business of an electricity company in all branches. To manufacture, provide, and dispose of works, machinery, mechanical instruments, and other appliances and apparatus for the production, generation, accumulation, storage, transmission and supply of light and heat, magnetic or other force or agent, and of regulating or measuring the supply thereof, and to acquire and work patents for such purposes. Signatories (with 1 share each): *Geoffrey Fowell Buxton, *A. R. Chamberlain, *Isaac Bugg Coaks, *R. J. Colman, *C. R. Gilman, *F. W. Harmer, *G. B. Kennett, all of Norwich and neighbourhood. The signatories are the first directors, and their remuneration will be determined by the company in general meeting; qualification for future directors, £250 in shares or stock. Registered 25th inst. by G. B. Kennett, Norwich, solicitor.

**Morgan's Automatic Electric Signal System Syndicate, Limited.**—Capital, £5,000 in £100 shares, with power to increase or reduce. Objects: To acquire, work and develop inventions, patents, secret processes, or rights of any kind connected with Morgan's automatic electric signal system. Signatories (with 1 share each): A. H. S. Daniell, 76, Finsbury Pavement; J. Ellis Hawkins, 36, Baker Street and 17, Paternoster Row; J. Offord, 6, Boundary Road, N.W.; Otto Frederici, Oncot, Muswell Hill; H. E. Walter, 16, Torrington Square; Hy. Pound, 99, Fenchurch Street; W. Roberts Moore, 152, Portway, West Ham. The signatories are to appoint the first directors; qualification, membership of the company; remuneration, £100 per annum each. An unregistered agreement of 24th inst. with Otto Friederici will be adopted. Registered 27th inst. by Hindson Miller and Vernon, 8 and 10, Moorgate Street.

**Universal Electric Light and Power Trust Corporation, Limited.**—Capital £5,000 in £10 shares. Objects: To invest the moneys of the company in any company, trust or corporation formed for the supply of electric light, heat and power, and to promote form and register any company for such purposes. 400 of the shares are founders' shares and will be entitled to one moiety of the surplus profits after payment of £8 per cent. dividend on the ordinary shares. Signatories (with one share each), Austin Cope, 28, Finsbury Park Road; E. T. Bryer, Coolhurst Road, Crouch End; A. R. Morison, 32, Gloucester Terrace, W.; H. Taylor, 39, Mount Pleasant Road, Stroud Green; S. Cronin, 4, Buckingham Street, Fitzroy Square, W.C.; W. Alexander, 24, Moselle Avenue, Noel Park, N.; F. A. Forbes, 7, Featherstone Buildings, W.C. Most of the articles of table A of the Companies Act, 1862, apply. Registered 28th inst by F. H. Harvey Samuel, 1, Whittington Avenue, E.C.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Williamson Electrical and Engineering Company, Limited.**—The statutory return of this company, made up to the 10th inst., was filed on the following day. The nominal capital is £5,000 in £10 shares. 250 shares are taken up and £5 per share has been called thereupon. The calls paid amount to £998 and unpaid to £252. Registered office, 14, St. Ann Square, Manchester.

**Hamilton, Griffin and Company, Limited** (Constructors of railways, telephones, telegraphs, electric light and power systems and waterworks).—The statutory return of this company, made up to the 16th October, 1889, was filed on the following day. The nominal capital is £20,000, divided into 5,000 A, 5,000 B, and 10,000 ordinary shares of £1 each. Seven ordinary shares were taken up at the date of the return, and upon these no call had been made. Registered office, 29, Essex Street, Strand.

**Electrical Accessories Company, Limited.** — The statutory return of this company, made up to the 24th October, 1889, was filed on the following day. The nominal capital is £5,000 in £1 shares. Seven shares have been subscribed for and the full amount has been called up, but at the date of the return had not been paid. Registered office, 66, Victoria Street, S.W.

**Economic Gold Extraction Company, Limited** (chemical and electrical).—An agreement of 3rd ult. between this company and C. E. Mildenhall, of 27, Clements Lane, provides for the allotment to the latter of fully paid shares to the nominal value of £122,000, being part of the consideration of £125,000 for the purchase of certain patent rights for improvements in amalgamating gold and other metals, and in apparatus employed therein granted to Messrs. B. C. Molloy and Bayston and the Hydrogen Amalgam Company.

The statutory return of the company, made up to the 3rd inst, was filed on the same day. The nominal capital is £175.000 in £1 shares. 140,000 shares are taken up, 122,000 being considered fully paid. Upon 18,000 shares 15s. per share has been called up, the calls paid amounting to £11,805, and unpaid to £1,695. Registered office, 1, Basinghall Street.

## CITY NOTES, REPORTS, MEETINGS, &c.

### Anglo-American Telegraph Company, Limited.

In the report of the directors to be presented at the ordinary general half-yearly meeting of the proprietors, to be held at Winchester House to-day, the 31st day of January, it is stated the total receipts from the 1st July to the 31st December, 1889, including the estimated balance of £2,465 1s. brought forward from the last account, are estimated at £157,109 4s. 11d. This amount, however, is subject to revision, dependent upon the result of the law-suit still pending between this company and the Paris and New York Company.

The traffic receipts show an increase of £23,839, as compared with the corresponding period of last year, and this increase would have been considerably larger, had it not been for the interruptions which have occurred during the past year to the cables of the associated companies. For some weeks during the half-year under review, the whole of the traffic was thrown on to the cables of this company, and, in consequence, its volume was sensibly diminished.

The total expenses of the half-year, including repair of cables, &c., as shown by the revenue account, amount to £58,611 12s. 3d.

Interim dividends of 12s. 6d. per cent. on the ordinary stock, and 25s. per cent. on the preferred stock, were paid on the 1st November last, absorbing £43,750, leaving an estimated balance of £54,747 12s. 8d., out of which the directors recommend the proprietors to declare final dividends of 15s. per cent. on the ordinary stock, and £1 10s. per cent. on the preferred stock, amounting to £52,500, making a total distribution for the year ended the 31st December, 1889, of £2 15s. per cent. on the ordinary stock, and £5 10s. per cent. on the preferred stock, leaving an estimated balance of £2,247 12s. 8d. to be carried forward to the next account.

The company's repairing ss. *Minia* has been engaged during the past half-year in the repair of the Brest-St. Pierre cable broken on the 17th July, communication having been restored on the 5th September, 1889. When at some distance from Falmouth, she unfortunately came into collision with an Italian barque, the *Caterina Capurro*, of Genoa, during a dense fog; considerable injury was sustained by both vessels, but as the *Minia* was insured, no direct loss was sustained by the company beyond the loss of time involved in refitting and the consequent necessity of employing the Telegraph Construction and Maintenance Company's ss. *Britannia* to repair another fault which appeared in the Brest-St. Pierre cable on the 14th November at 150 miles from St. Pierre. The *Britannia*, after picking up both ends of the cable, and renewing 35 miles by laying in new cable, was driven by stress of weather and shortness of coal to temporarily abandon the work and return to port. In the meantime the *Minia* had arrived at St. John's, Newfoundland, and, being fully equipped, at once proceeded to the spot and successfully completed the repair on the 12th December.

The whole of the company's system of cables and land lines is now in good working order.

The litigation between the Anglo-American Telegraph Company and the Paris and New York Telegraph Company is still pending, the appeal to the Conseil d'Etat not having yet been heard.

The directors are pleased to be able to report that the Western Union Telegraph Company, lessees of the American Telegraph and Cable Company, have extended their main cables from the landing place at Canso, Nova Scotia, by new cables direct to New York City. This extension will not only greatly expedite the traffic all the year round to the joint benefit of the associated companies, but will neutralise the effect of storms upon the land wires, which during the winter occasionally caused delay in the transmission of messages.

As a result of adding to the carrying capacity of the Western Union Company's system by the above extension of their cables, they have been enabled to transfer to this company the use of two wires between North Sydney and New York City, and under agreement between the two companies, this company will shortly open an office at No. 8, Broad Street, New York, and thus establish direct and complete telegraphic communication between New York and London by their own lines. By the opening of this new office and the extensions referred to, the company will be placed "in touch" with the New York public, and the directors hope that the more certain and accelerated service now provided will increase the traffic upon the cables of all the associated companies.

In accordance with the articles of association, two directors of the company, the Right Honourable Viscount Monck and Samuel Barber, Esq., retire at this meeting, and being eligible, offer themselves for re-election. The directors greatly regret the loss by death of their colleague Sir Daniel Gooch, Bart., who has been connected with the company from its inception, and assisted in the laying of the original cables. Mr. Charles Burt, till now solicitor to the company, having retired from professional business, has been elected to fill the vacancy during the remainder of Sir Daniel Gooch's term of office. The directors consider that Mr. Burt's intimate knowledge of the company's affairs from the commencement of the undertaking will render his services exceptionally valuable.

Mr. Joshua Dean and Mr. Francis Glass, the auditors, also retire. Mr. Dean offers himself for re-election, but Mr. Glass, on account of failing health, does not desire re-election, so that the appointment of a new auditor will be necessary.

### Australasian Electric Light, Power, and Storage Company, Limited.

At an extraordinary general meeting of the shareholders of the above company, held at the registered offices of the company, situate at 39, Coleman Street, in the City of London, yesterday, the following resolutions were passed, viz.:—

"That this company be wound up voluntarily."

"That John Henry Hill Duncan and Benjamin Humphries Van Tromp be, and they are, hereby appointed liquidators of the said company."

"That the said liquidators be, and they are, hereby directed to carry into effect the agreement entered into between this company and the Brush Electrical Engineering Company, Limited, dated October 23rd, 1889, so far as the same remains to be carried out, and either with or without modification."

**Woodhouse and Rawson United, Limited.**— This company announce an interim dividend for the half-year ending 31st December, 1889, in respect of profits realised since its formation, at the rate of 8 per cent. per annum on the preference shares, and of 15 per cent. on ordinary shares, payable on the instalments from the date of their payment.

### TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 24th after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £4,044.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending January 24th, 1890, amounted to £5,554.

## THE CONNECTION OF LIGHTNING RODS TO GAS AND WATER PIPES.

Reported by A. FISCHER, of Berlin.

(*Continued from page* 93.)

### 6. *The Proposals of the Minority.*

As already mentioned, there existed differences of opinion concerning the dangers which might possibly arise from the junction of the lightning rods. Proposals were consequently made from two quarters which more or less decidedly recommended the refusal of the desired connection.

Herr Reissner moved that :—

"The German Association of Gas and Water Officials is not convinced either of the necessity or the utility of a connection of domestic lightning rods to the domestic piping and the mains of gas and water companies.

"It cannot recognise any need for the connection, and on purely practical grounds, and in the interest of the gas and waterworks cannot regard such junction as admissible."

In case of this motion being negatived, Reissner proposed as follows :—

"The German Association of Gas and Water Officials, is not convinced either of the necessity or the utility of connecting domestic lightning conductors to domestic piping and to the gas and water mains. The Association considers that the dangers to buildings existing, in the opinion of electricians, are greatly exaggerated, and does not admit the dangers to the systems of pipes which would call for a connection to the lightning rods.

"The Association demands, as a preliminary for the admissibility of connection, that the lightning rods should be technically faultless, and should also be subjected to periodical inspection.

"On the ground of previous experience the Association is not of opinion that such inspection can not be effected by private means. Hence it considers, under present circumstances, the connection of the lightning rods to the mains inadmissible, nor can it lay down conditions under which the connection might be permitted until

"1. Compulsory regulations on the construction and fixing of lightning rods are issued by competent authorities, and until

"2. A guarantee for the permanent good condition of the lightning rods is furnished by a regular periodical examination.

"As, however, the Association does not recognise any advantage in the connection it does not hold it necessary to take any steps in this direction."

Both these proposals failed to meet the assent of the Commission, as they do not take actually existing circumstances into account, and the question, especially in the second amendment, is left very unpleasantly undecided.

Lastly, "general director" (probably managing director of some gas or water company), Dr. Schilling sent in the following proposal :—"The Association declares that the connection of the lightning rods to the water and gas pipes can neither be recognised as necessary, nor, from practical reasons, can it, in the interest of the companies, be generally admitted."

As Dr. Schilling was prevented by illness from taking part in the sessions of the Commission, he gave the following reasons for his proposal :—

Munich, *June* 2nd, 1889.

The report of the Commission arrives at the result :—

1. That as increased danger to buildings from lightning in consequence of the gas and water pipes is not demonstrated.

2. That the danger of injury to the pipes does not supply a reason for the necessity of the connection.

3. That the freedom of the connection from danger cannot be admitted in all cases, since it may directly occasion danger by introducing high electric tensions into inhabited rooms.

4. That there exist a number of practical objections to the permission of a connection.

This is substantially the result at which I arrived in my report of last year, and in so far I agree with its recommendations.

It is different with the position which the report suggests the Association should assume.

I am of opinion that the task of the Association should be simply confined to the interests of gas and water companies, and be content with the practical demonstration that the proposed junction can neither be regarded as necessary nor can it be generally admitted by the gas and water interests.

If a municipality or a gasworks resolves to permit the junction, it is free so to act, and it may then wish for advice as to the execution and regulation of the connections.

On the contrary, the report proposes the connection admissible under certain suppositions and conditions —*e.g.:*

1. In order to meet the desire so urgently expressed by the electricians on physical reasons.

2. In order to meet as far as possible the irregular and perhaps dangerous positions arising from secret junctions. I belong to those who give full weight to the theoretical-physical reasons of the electricians, but in this question practical objections can be opposed to these theoretical arguments. Rightly to appreciate these objections does not fall within the competence of the electricians but is a speciality of the representatives of our department.

Every town must retain the free choice to regulate its policy more according to the recommendations of the electricians or the association of the practical specialists. But our Association has simply to be guided by the practical conviction based on prolonged experience.

The argument that the junction should be permitted lest it be effected secretly cannot be admitted. Such an argument does not seem suitable for regulating the existing disorganised state of the lightning conductors, and to guard the gas and water companies against unpleasant experiences.

The junction of the lightning rods which necessitates a number of new suppositions and conditions would deteriorate instead of improving the present state of affairs.

The majority of the Commission cannot accede to these representations.

The promotion of generally valid regulations and rules for putting and keeping existing lightning rods in good condition, is scarcely the business of the Association. Within its own sphere of action it effects the same object sufficiently by accepting the proposal of the Commission, since a due inspection would be secured in all cases where the lightning rods are connected.

Schilling's proposal merely expresses that negatively which the proposal of the Commission does positively, and under special conditions.

Schilling says : "The Association declares that the junction cannot be generally admitted ;" that means that it can be allowed in special cases. The proposal of the Commission says : "The Association views connection as admissible under certain strictly defined conditions," *i.e.*, by no means universally.

To accept Schilling's proposals would raise questions as to the possible admissibility of junctions. It seemed to the Commission advisable, as far as it can be done on the basis of present experience, to fix the conditions under which the connections are admissible from the point of view of the gas and water companies, disregarding all responsibility for the possible dangers to the inhabitants of houses.

The acceptance of the proposals of the Commission must therefore be recommended from these points of view.

The reporter then read the proposals of the majority and of the minority, adding that it has been suggested that the Commission should place itself in communication with the Association of Architects and Engineers, and

with the Electrotechnical Association, and to consider the question in common. This joint deliberation took place on May 10th, and the result is as follows :—

There were present; on behalf of the Electrotechnical Association, Prof. Von Bezold, Dr. Von Siemens, Prof. Neesen and Dr. Brix ; on behalf of the gas and water officials, HH. Salzenberg and Reissner ; and on behalf of the architects and engineers, Director Kümmel, Prof. Kohlrausch and Dr. Allbricht. Prof. Von Bezold was chosen president, and H. Pinkenburg (a representative of the Gas and Water Association) secretary.

Herr Kümmel had been under the impression that the gas and water officials would display a greater resistance than had so far appeared. He considered it desirable that certain points should be agreed upon concerning which differences of opinion prevailed between the electricians and the gas and water officials, *e.g.*, concerning the necessity of ground-plates. There ensued a long discussion, from which it appeared that there did not exist among those present any principal objection to the connection of the lightning rods to the gas and water pipes provided it is suitably carried out, and that the piping has metal junctions.

After mature deliberation the following resolutions were agreed on :—

1. Besides the connection of the lightning rods to the system of pipes it is from practical reasons requisite to furnish the conductor with an earth plate.

2. If several systems of pipes are present it is desirable to connect the conductor to all.

3. A connection of the lightning rods to the pipes should be effected as close as possible to the street mains, and a good metallic connection between them should be secured.

4. A further connection of the lightning rod to any branches of piping in the upper storeys of houses is recommended.

5. The inlet and outlet pipes of water and gas meters should be bridged over by a metallic connection.

It was lastly resolved to communicate these resolutions to three associations, and to recommend their adoption.

On comparing these resolutions with the proposals of the majority of the Commission it appears that as regards supplying each conductor with a ground plate there is no difference of opinion. A like agreement prevails as regards resolutions No. 2 and 3. No. 4 recommends the connection of the lightning conductor to the pipes in the upper storeys. But according to the proposals of the Commission the Association should refrain from any recommendation of connections, either in the upper storeys of the houses or altogether, but merely declare them permissible under certain general conditions.

No. 5 agrees with the proposal of the Commission.

Herr Teucher, a municipal councillor of Dresden, spoke of the impossibility of arresting a tendency which was felt both in Germany and abroad, and considered it better to attempt a reconciliation of the conflicting views.

Referring to a supervision of the lightning rods, he expressed himself convinced of its necessity, since a bad conductor is much more dangerous than none at all.

The alleged danger to workmen from the connection of the lightning rods to the street mains, he considered unimportant. According to statistical returns, most thunderstorms take place between 9 p.m. and 4 a.m., that is, in the time when no one is at work. Further, the time from 6 to 11 a.m. is remarkably free from such storms, so that the alleged danger may be said to vanish.

As regards the danger to the piping, the speaker reminded the meeting of a case which it had fallen to his duty to examine personally. This was when the lightning struck the water-main at Torgan, as described in the *Journal für Gasbeleuchtung* for 1888, p. 797. In opposition to the purely negative and prohibitive attitude assumed in some quarters, the Commission has given in its report positive indications as to the conditions under which a connection should be permitted. This difficult work seems very valuable, since it affords proposals suggested by experience upon which confidence may be placed.

Herr Hegener, a gas (or water) director of Cöln, said :—"The reporter has already informed you that although a member of the Commission, I have not been in a position to take part in its labours. I regard it as my duty not to keep back my opinion.

"I quite agree, substantially taken, with what the reporter has said, and especially with the first sentence. I approve of the declaration that the Commission, according to the statistical evidence before it, is not convinced of the necessity of a connection of the lightning rods to the gas and water mains. I agree with the passage in which the Commission declares that it sees in such connection, under certain circumstances, even a source of danger. But I believe that from this basis and from the other points which have been mentioned we may draw a conclusion different from that of the Commission. From this basis we may, in fact, arrive at a completely opposite proposal to that of the Commission which is probably the reason why Reissner and Schilling declared themselves last year opposed to the connection.

"I find no positive statistical basis for an actually existing and wide spread danger supposed to be created by the want of a connection of the lightning rods to the gas and water pipes, and I believe that so far there is no cause for this danger. (The editor of the *Electrotechnische Zeitschrift* marks this sentence with !) According to my somewhat extended experience I can merely say that with me such a danger has never been practically apparent. I have been quite surprised at seeing in the proceedings of other associations how enormously necessary must be the lightning rod connection, which I have hitherto never experienced. We have at our works about 100 lightning rods with ground connections, and we have fortunately—I fully admit it may not always so happen—never had any serious accidents. On the other hand, I have seen here in Stettin the effects of a lightning stroke which shattered a chimney ; also at the Cathedral of Cöln a piece of the ornaments of the cross was struck off without the gas and water pipes being concerned (!) I think that there has been, here and there, gross exaggeration, and that in the first place we ought to ascertain the degree of the really justifiable apprehensions by a judicious collection of facts. When this has been done we may begin to take suitable measures against the existing evils. To do this beforehand, I consider would be unjustfiable, especially from our point of view.

"As in the conclusions drawn the reporter has made proposals for the conditions which must be observed if the connection is permitted, I can give in my adhesion almost on all points. I consider it very just that we should seek to lay down the conditions for the connection, even if we are opposed to such connection, since we cannot, without stating our reasons, remain in an attitude of mere negation. I can, therefore, in general accept the proposals, especially the one that every lightning conductor must have, above all things, a ground plate, a proper earth connection. Another point is the supervision and maintenance of the existing lightning rods. We have a general examination at least once a year. Further, a special examination is necessary after every severe thunderstorm. We also take care that every conductor has a perfect connection with a plate down into the ground water. If a connection to the mains is generally permitted, or if it takes place in this or that place from peculiar reasons, I should recommend strict attention to the principle of keeping the connections in good order.

"As to the second point, that the net of mains underneath the streets, should consist of cast iron pipes fitted into each other and joined with lead or other good conductive material. I must remark that such an arrangement, if necessary, furnishes an argument against the proposed connection, since we have various methods of connecting water pipes to which this regulation is inapplicable. Thus we have flanges with caoutchouc washers. Latterly, we have wrought iron

pipes, very important for certain purposes which can only be connected with caoutchouc.

"As to the other proposed regulations I will mention only one point which seems not to have received due attention—the right of property in the pipes. From this point of view I think it absolutely impossible that a general permission for the junction should ever be given."

(*To be concluded.*)

## THE BROOKLYN SUBWAYS.*

FINAL REPORT OF THE COMMISSION—INTERESTING REVIEW OF THE UNDERGROUND AND OTHER WIRE WORK IN BROOKLYN.

(*Continued from page* 105.)

In Philadelphia, and to some extent in New York, when the so-called Johnstone system of underground house connections has been tried, explosions have occurred which were plausibly ascribed to intentional or accidental lighting of accumulated gas in the cellars. Since this system has been loudly advocated as a "complete solution of the problem," it may be well to add that the board, after careful examination of it, including a special report by a competent expert, considers it to be unsafe as to house connections, and adheres to its original conclusion that such connections should be aerial, unless they are so permanent that they can be made, once for all, perfectly safe (by solid filling or otherwise) against the entrance of noxious or inflammable gases into the houses.

It is probably because of these house connections, open or liable to be open, that the natural ventilation of the subways, as practiced in Brooklyn, has not been resorted to in other places. At least, this is the only reasonable explanation of such an omission. For the experience of colliery engineers with inflammable hydrocarbons and their explosive mixtures with air proves that such gases, by reason of their lower specific gravity, tend to hug the roofs of all confined spaces, and to escape by all upward vents, and that they mingle but gradually with the heavier air; so that, if not left alone too long, or entering suddenly in too large a volume, they can be drawn off.

The comparatively small amount of gas ordinarily entering a subway can be thus removed by simply ventilating it, particularly at manholes and at saddles or grade summits, through pipes or boxes extending to a sufficient height. In the Brooklyn system, these ventilators often serve also as ducts to the distributing points on the house tops or poles. Thus, from the manholes near the elevated railways, three-inch iron pipes both act as ventilators and carry the cables to and up the railway columns. A cable carried from the subway up a pole or the side of a house for the terminal distribution of its constituent wires is enclosed in a box, which thus ventilates the subway. Special ventilators are also employed when needed.

The attempt to ventilate conduits by means of fans is not a good substitute for the natural system. As mining engineers are well aware, suction fans are better than blowers, where fans are required. For the suction will draw out the dangerous gases while blowing may merely bank them up, and by forcing air into them, convert what was previously only inflammable into a dangerously explosive compound. But suction fans have failed in their application to subways, for the reported reason that they draw into the conduits additional gas, increasing the leakage in proportion as they diminish the interior pressure below that of the atmosphere. Hence, the usual practice is to blow air into the conduit, and hope that it will blow the gas out, a neighbouring manhole being generally opened for the escape. This, it is confessed, whenever there are house connections open or leaky, will force gas into the cellars; and the mixture of gas and air thus produced will be explosive. On the whole, therefore, this board is entirely content to have succeeded in avoiding the conditions requiring such desperate remedies. If fans are used on the Brooklyn subways (as they may be for special and temporary purposes, such as clearing out a manhole for the comfortable entrance of workmen, by removing not merely the light inflammable gases, but the heavy carbonic acid which may collect in underground spaces), they will blow neither poisonous nor explosive mixtures into stores and dwellings. And so long as the system adopted by the board shall be intelligently maintained, our citizens need not fear, as the latest result of scientific enterprise, the sudden and inexplicable uprising of pavements and sidewalks, in exchange for the previous perils of wires and poles.

Under the head of the public convenience, the board rejected "solid conduits," as involving, except when installations are permanent, an intolerable frequency of excavation, and as not permitting, without such excavation, the change and repair of conductors. Since good pavements are all important, and no pavement (except, perhaps, an asphalte one), can be good if it is repeatedly broken and partially relaid, this consideration should be absolutely conclusive. The board, moreover, by adopting a subway in which conductors could be conveniently changed at will, was enabled to lay upon the electrical companies the entire burden of the purely electrical problem. But one requirement was made of the companies in this direction, namely, that they must be prepared to use metallic instead of grounded circuits (that is, to use at least twice as much copper for the same amount of service) if that should be found necessary to the successful operation of the new system. It was found necessary, and for a large part of the telephone system it has been done. The size of the copper conductors, and consequently of the cables, has also been increased, and this has required a trifling increase in the original size of the conduit ducts. Otherwise, the whole system is operating to-day with perfect success on the lines originally laid down, and the board has not been obliged to retrace any step once taken.

At one time there existed serious apprehension that this satisfactory record might be broken. The corrosion of the lead covering of the cables in the subway was strongly asserted to be due to the creosoted wood; and one concern employed in the manufacture of such cables declined to guarantee them if laid in such a conduit. It was found that alloying the lead with about 4 per cent. of tin would prevent serious corrosion; but this rendered the metal somewhat harder to work as well as more expensive. A fibrous covering over the cable was also reported to be a sufficient protection; but this, in the opinion of the board, though not seriously objectionable, might either cause difficulty or receive injury during the drawing of the cable into the subway. The telephone company in Brooklyn manufacturing for the most part its own cables, preferred the tin alloy; and the board, satisfied that the creosoted conduit, so excellent in other respects, need not be condemned on this account, continued to approve its extension, while studying carefully the symptoms and causes of the corrosion of the cables.

The product of the corrosion appeared to be lead carbonate, and this pointed to carbonic acid gas as the active agent. This gas being present in illuminating gas, and especially in that made by the modern method from "water gas," it was natural at first to ascribe the corrosion to its action, and cases reported to the board in which cables laid in iron or concrete ducts had been corroded seemed to confirm this view. On the other hand, naked lead pipes laid in the soil are not specially subject to corrosion, except when they are exposed also to organic acids; nor does carbonic acid act with great vigour upon metallic lead at ordinary temperatures. Experiments in the laboratory show a slight coating to be produced by long exposure to currents of the illuminating gas used in Brooklyn, but not such as to fully account for the destructive effects observed in several instances in the subway. It was further noted that different parts of the subway exhibited different degrees of corrosion, even upon cables of similar constitution; and the conclusion was finally indicated that some variable (and therefore probably volatile) constituent in the creosoted wood initiated and intensified the action of the carbonic acid. A series of careful analyses performed for the board by Prof. Richardson, the head of the laboratory of the Cooper Union, proved this constituent to be phenol, which, being highly volatile, either escapes from the wood in the process of seasoning or could be expelled more rapidly if required by artificial means. Several observed cases indicate that the creosoted wood loses after a time the tendency to promote corrosion; and the analyses of the corroded material show that the phenolate of lead is a main ingredient. The board is therefore inclined to the opinion that the removal of the phenol, by time or otherwise, from the creosoted wood will prove a remedy for the evil of corrosion, perhaps rendering any other remedy unnecessary.

It remains to state the considerations actuating the choice of this system in its relations to future and more comprehensive ones. The board was naturally unwilling, by the adoption of any partial and temporary expedient, to forestall some better arrangement; but any apprehension of this kind was removed by a careful study of the problem.

This problem is primarily municipal rather than scientific. In the rapid extension of the acknowledged benefits of electrical distribution large cities have been brought into contact with serious evils, which it was the primary purpose of legislation upon the subject to remove. These evils are:—

(*a*) The nuisance of poles and overhead wires disfiguring the streets and buildings and interfering with the work of firemen. This evil is real and great.

(*b*) The dangers of such poles and wires may be classified under three heads:—Danger of injury caused by their fall; of fire, caused by their incandescence; and of death, caused by the passage of the electric current through men or animals. The first of them may be disregarded. Authentic instances of such casualties are exceedingly rare. The second is peculiar to "quantity" currents, usually of low tension, and affects especially the interior of buildings in which incandescent lights are used, though it may be caused also by the escape of electrical currents from their proper conductors, to conductors too small or too highly resisting to convey the currents without great rise in temperature. Thus the current from an electric light wire, entering a house upon a telephone wire, will burn out the interior coil of the telephone instrument, and may thus set fire to the house. The third danger originates with the high tension conductors, but affects all wires whatever with which these may come into electrical contact, or to which their powerful currents may leap. No wire, however harmless in itself, or however harmless the purpose for which it is intended, can be safe while there is a chance that it

* New York *Electrical Review*.

may form a connection for some destructive current communicated to it by another wire. In fact, the telephone and telegraph wires, entirely harmless by themselves, are in this respect the most dangerous of all, because they are naked, while the high tension conductors are more or less completely insulated. Such a high tension conductor, for instance, though completely insulated at every point but one, may, through contact at that one point, render a great length of ordinary wire fatal at *every* point to man or beast touching it. And this is exactly what happens in a large proportion of cases. A telegraph wire has fallen across an electric light wire, sawed through its insulation, and received its current; and some hapless victim touches, not the original conductor, but the naked secondary conductor, with terrible results.

To cure all the above evils at once the decree was made that all electrical conductors of every kind should be buried forthwith underground. But it is certain that in the present state of electrical science, high and low tension currents should not be placed in close proximity, either under or above ground. Aside from the effects of induction (to be mentioned hereafter), it is not safe to carry through the same manholes the telephone wires connected with innumerable houses, and the cables conveying highly destructive currents. The board is quite aware of many apocryphal and a few authentic instances, in which this is said to have been done without difficulty or disaster. It is quite as possible, theoretically, by scientific devices, to secure safe insulation as to diminish to a minimum the disturbances of induction. So it is possible to enclose a keg of gunpowder beyond the danger of ignition, but that does not make it an advisable stand for a kerosene lamp. Or, a cannon may be so connected with clockwork that it will not go off until noon; but nobody is therefore wise who sits down before it at half-past eleven. In short, neither anything heretofore invented, nor anything likely to be invented hereafter, can render it advisable to collect unnecessarily the elements of danger, relying for immunity on the correct operation of scientific precautions, and the constant intelligence and vigilance of workmen. Consequently whether high and low tension conductors can or cannot be, they never ought to be buried in proximity.

It follows, then, that they should either be placed underground in entirely separate and suitably protected systems, or that one or the other, or neither, class should go underground at all. The last alternative may be rejected at once. Apart from all other reasons, the consideration of safety dictates as wide a separation of the two classes of conductors as possible. That they should be left to cross and tangle in growing multiplicity above ground is intolerable. Unless both can be practicably buried, then, which class shall we bury?

In answering this important question, the board contravenes high foreign authorities, who assert that the two classes cannot be operated underground, and that the true plan is to bury the high tension conductors, and have the telephone and telegraph wires in the air, free from perilous neighbours. With this conclusion the board does not agree, for the following reasons:—

(*a*). It is not yet certain that electric light wires can be operated successfully through subways. The distinguished director of the Turin system in Italy, since he advocated to a member of this board the exclusive burying of high tension conductors, has seen his electric light cables fail, after less than three years' service. Until this practical question is settled, it would be unwise to risk all reform upon the most doubtful part of the problem.

(*b*). But whenever this question has been solved, as this board does not doubt it will be, then it is believed that the burying of both systems in separate subways will be practicable.

(*c*). Meanwhile, the telegraph and telephone wires can be so buried and separated, and their removal from poles and houses will remove the greater part not only of the nuisance, but also of the danger. For it is perfectly possible to make the high tension currents, *if these numerous naked wires are out of the way*, as safe as they would be underground. But this cannot be perfectly done (though great improvement might be effected in the present state of affairs), so long as those wires remain.

If, then, it should prove impossible (which this board, however, does not believe), to devise any commercially practicable and safe method of operating underground conductors of high tension currents, the burying of telephone and telegraph wires, coupled with proper inspection and control of the dangerous aerial wires remaining, would be not intolerable as a substitute. And until that better result can be reached, this substitute should be adopted.

Hence, it was concluded, the feasible but partial scheme adopted by the board would not impede the further progress hoped for. While acting in this direction, however, the board has been constantly engaged in the study of further possibilities, watching all developments of practice elsewhere, corresponding with municipal and electrical authorities throughout the United States and in foreign countries, visiting in person or through its own experts the scenes of reported successes or failures, hearing inventors, consulting eminent practical authorities, and directing experiments. The general opinions to which it has been led are stated in the following pages of

THE PROBLEM OF ELECTRICAL DISTRIBUTION.

The public distribution of energy from central points of generation is one of the most important elements of modern civilisation. Since light, heat, motive power, chemical energy, electricity, &c., are all forms of energy, convertible, the one into the other (though in the present stage of applied science with varying degrees of practical economy), it is evident that the vehicle of distribution which will safely, cheaply and conveniently deliver to the consumer all, or the greatest number, of the desired forms of energy, will ultimately find general adoption. This has been foreseen ever since "the correlation of forces" was established as a natural law, and the foresight has led to continual attempts to multiply the applications of existing modes of distribution. Thus, illuminating gas, originally giving light only, is now proposed for house-warming, cooking and (through gas engines) motive power; and the motive power thus furnished is turned by a further transformation of energy into electric light, &c. Water under pressure of heat, steam and superheated water and compressed air are well-known conveyers of motive power. Into this field the electric current now enters as a carrier of energy, and although its mechanical apparatus is as yet far from perfect in economy, efficiency or safety, it has made, especially during the past five years, such wonderful advances, and it promises such advantages over other means, that it must be deemed a permanent improvement, certain to receive rapid extension; and provision must be made for it in municipal administration and engineering.

The telegraph and telephone do not employ large amounts of energy, and cannot be used as vehicles of its distribution for other uses. Their currents are not dangerous,* although, as above explained, their conductors may become so.

The placing of such conductors underground is not difficult. Whether it can be done in a given case, without commercial ruin, depends upon the cost of the operation and the earning power of the conductor. Main lines of telegraph certainly can be fairly required to go underground in large cities. The earnings of the telegraph are proportioned to its business and limited only by the capacity of transmission. This capacity is somewhat reduced by placing the wires underground; but the loss is practically counterbalanced by reduced cost of maintenance.

(*To be continued.*)

## ELECTRIC LIGHTING AT BRIGHTON.

THE scheme for the supply of the electric light to Brighton by the Corporation (a summary of which appeared in these columns last week) was made the subject of a protracted discussion at the meeting of the Council last week. The Lighting Committee, it will be remembered, recommend that the Council should themselves undertake the supply of the electric light and should seek permission to borrow £30,000, the estimated outlay for the construction of the necessary preliminary works. The Council obtained the necessary powers in 1883, and it will only therefore be necessary to oppose the application of the Brighton Electric Light Company, who have hitherto been the purveyors of the light in the town, for further powers enabling them to lay underground mains.

In moving the adoption of the report Dr. EWART (chairman of the Lighting Committee) explained that upon the passing of the Act of 1888 the Brighton Electric Light Company applied for a provisional order to supply the light to the inhabitants of Brighton. Last January the Corporation opposed the application, and stated substantial reasons why they had not proceeded upon their authorisation obtained in 1883. They had now before the Council an able report by Mr. Shoolbred, and he moved—"That electric lighting works be established with the necessary plant, machinery and appliances, and that proper mains be laid under the public streets for the supply of electricity by the Corporation for public and private purposes within the borough under the powers of 'The Brighton Electric Lighting Order, 1883.'"

The motion was seconded by Mr. TUFF.

Mr. E. A. DELL opposed the motion, and said that no allowance had been made in the estimate for royalties. He knew that some companies spent as much as £100,000 in this way alone. He was quite certain that before the whole thing was finished they would be involved in an expenditure of £300,000. They were not sent to the Council to speculate with the ratepayers' money. Let them look at the Pavilion. They had spent plenty of money on the installation, and they hadn't even a light outside the building.

Mr. NELL also opposed the motion.

Mr. BALLARD expressed an opinion that every penny voted that day would be absolutely wasted.

The TOWN CLERK read two memorials, one in favour and one against the motion.

The MAYOR remarked that the time had come when the Corporation should take over the lighting of the town.

The resolution was then put, and carried by thirty-five votes to three.

Dr. EWART moved: "That the system of supply to be adopted should be the continuous current system at low pressure combined with storage batteries," and after a deal of discussion this was agreed to.

Dr. EWART next moved a resolution defining the district to be supplied by the Corporation, which was adopted. The same speaker again moved: "That works for the supply of electricity within the extended area of supply as defined, and in accordance

* Except as any current which may under any circumstances give a spark, is dangerous in the presence of explosive gas—which the smallest spark may ignite.

with, the foregoing resolutions, be forthwith established at an estimated cost of £30,000, and that the Town Clerk do apply to the Local Government Board for sanction to borrow the said sum of £30,000 on security of the general district rates, the same to be repaid within a period of 40 years." This was agreed to without discussions. Dr. Ewart next moved: "That the committee recommend that the price to be charged for any electricity which may be supplied by the Corporation shall be at the rate of 6d. per unit," which was carried, as was also a resolution: "That the committee be authorised to select a suitable site, or sites, for the works, to provide all the necessary machinery, plant, and appliances, and to prepare and submit for the approval of the Council such contracts as they think advisible for the supply, erection, and construction thereof, and for laying mains under the public streets." The recommendation of the committee, suggesting that Mr. Shoolbred's services should be retained, was held over, Dr. Ewart remarking that there were a few points of trifling importance to be cleared up. The council refused its consent to an application for a provisional order by the Brighton Electric Lighting Company.

## EASTBOURNE AND THE ELECTRIC LIGHT.

A SPECIAL meeting of the Town Council of Eastbourne was recently held to consider the report of the special committee appointed to consider the application of the Eastbourne Electric Light Company, for the assent of the Corporation to a draft provisional order authorising the company to supply electric light for public and private purposes within the borough. The committee recommended that the assent of the Town Council be given to the proposed provisional order, subject to the charge for the supply of the electric light being reduced to 15s. per 20 units, and 9d. per unit over the above 20 units; and also subject to a shaft being erected at the works to a height of at least 150 feet, so as to carry off all noxious or offensive fumes from the works, and thus prevent a recurrence of the nuisance from foul smells of which complaints have been frequently made to the Town Council.

A correspondence between the Town Clerk and Messrs. Langham, the company's representatives, was read in which the latter say, as regards the price:—"The company has been working experimentally on a sliding scale of 1s. per unit for the first 100 hours, 8d. for the second hundred, and 4d. for all above 200 hours per quarter; but the last figure is found to involve serious loss to the company, and, as a matter of fact, the company has not yet paid a dividend. Tenpence per unit has therefore been inserted in the order as the medium between 1s. and 8d. Our electrical manager has gone carefully into calculations and finds that the offered price of 9d. will not afford a prospect of a reasonable profit—and without such a prospect it is vain to expect capitalists to embark money in the undertaking," and they ask whether Eastbourne could be expected to provide the light at a cheaper rate than Birmingham, where coals are cheap and which is the manufacturing centre for engines, dynamos, wire and all other electric lighting plant?

As to the second point, whether the company agree to erect a shaft 150 feet high at the least to carry off any noxious fumes, &c., they answer frankly and distinctly "most certainly not, you may as well ask us to build an Eiffel Tower!" and they submit that such a condition is quite unnecessary, and, moreover, they deny that the company is the cause of any noxious smell whatever.

In the course of the discussion which followed, a Mr. Wallis moved as an amendment, which was eventually carried as a substantive motion, "That the report and recommendation of the committee be adopted down to and including the words 'Provisional Order'; the rest of the recommendation of the committee, from the word 'subject' to the end being struck out, and the following words substituted: 'And that accordingly the consent of the Council be given to the grant by the Board of Trade of a provisional order to the Eastbourne Electric Light Company, Limited, authorising the said company to supply the electric light for public and private purposes within the area of the borough of Eastbourne, and that the corporate seal be affixed to such consent, and also that the Town Clerk be directed to give all necessary certificates to satisfy the requirements of the Board of Trade.'"

## ELECTRIC LIGHTING AT CROYDON.

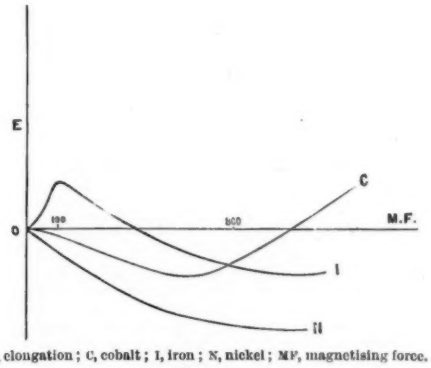
THREE different private companies are seeking powers to light Croydon, viz., the South of England House-to-House Electricity Company, Limited, the Croydon Electric Supply Company, Limited, and the Electric Installation and Maintenance Company. The matter has been under the consideration of a special sub-committee, who had before them a memorandum from the Town Clerk giving particulars of the different companies. At a meeting recently it was recommended by the General Purposes Committee that the sub-committee which has been dealing with the question, should be authorised to signify the consent of the Council to any of the three orders referred to in the memorandum, subject to the promoters agreeing to give an option of purchase upon certain terms, and to their consenting to such conditions and amendments as the sub-committee may think it desirable to insist upon; that the sub-committee should be authorised to instruct the Town Clerk to lodge such objections with the Board of Trade as the sub-committee may think necessary, with further power to instruct the Town Clerk to appear before the Board of Trade in support thereof, with power to employ counsel if thought necessary; that the sub-committee should be authorised to instruct the Town Clerk to oppose any order, the promoters of which may be unwilling to assent to terms of purchase being inserted, or decline to agree to conditions or amendments which the sub-committee may think necessary; that the sub-committee should be instructed to insist upon overhead wires being prohibited. These recommendations have been adopted by the Croydon Town Council, at whose meeting last week, it was stated that the committee would offer opposition to any proposal to charge more than 13s. 4d. for the first 20 units.

## PROCEEDINGS OF SOCIETIES.

### Institution of Electrical Engineers, January 23rd, 1890.

CONTINUATION of discussion on the President's address on "Magnetism." (*Authorised Abstract.*)

Mr. SHELFORD BIDWELL, in re-opening the discussion, said the address was above criticism and required no comment; but as he was greatly interested in the subject himself, he wished to refer to the portion of the paper (slip 7) relating to the influence of stress on magnetisation. If a long thin iron wire be suspended vertically and subjected to longitudinal magnetising forces, its curve of magnetisation resembling fig. 1 is easily obtained. If, now, the wire is stretched by a weight, the curve of magnetisation rises more rapidly at first, but subsequently bends over and cuts the ordinary curve, and remains below it as the magnetising force increases. The point of intersection is known as the *Villari critical point*, and the change in the relative permeability is called the *Villari reversal*. Converse effects were obtained by Joule in 1840, who showed that a bar is lengthened by magnetisation until the magnetising force reaches about 120 C.G.S. units, when no further elongation was observed. Joule's experiment has often been repeated, but until comparatively recently no one seems to have used much greater magnetising forces than those originally employed; the speaker, however, has subjected wires to forces of 800 or 1,000 C.G.S. units, the results of which are shown in the diagram (fig. A). From this it will be




E, elongation; C, cobalt; I, iron; N, nickel; MF, magnetising force.

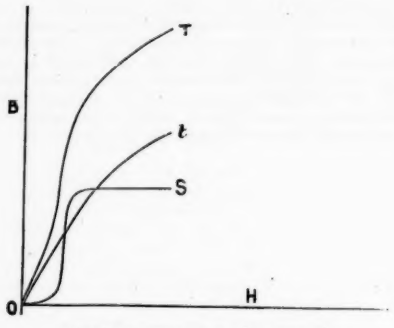
FIG. A.

seen that for forces above 100 the elongation diminishes as H increases, and eventually magnetisation shortens the bar. Similar curves for nickel and cobalt are given in the same diagram. In his "Applications of Dynamics to Physics and Chemistry," Prof. J. J. Thomson has shown the elongation and retraction of iron to be closely connected with the Villari reversal, and applying a similar argument to the properties of cobalt, Mr. Bidwell predicted that this metal would present a Villari reversal of an opposite character to that observed in iron, but on trying the experiment the reversal was not found. Probably, however, he had misunderstood Prof. Thomson's argument, for quite recently the latter had predicted a Villari reversal when cobalt was compressed, and this was verified by experiment.

Prof. ROBERTS-AUSTEN stated that there were, from the point of view of a metallurgist, several points in the admirable address to which he wished to direct attention. The President had said that wrought iron on cooling does not evolve heat as carbonised irons do. Prof. Austen, however, reminded the Society that electro-deposited iron (which is pure iron) does, on cooling down from 1,200° C., evolve heat suddenly when the temperature falls to 858° C. This points to a distinct molecular change in the iron itself, wholly unconnected with the presence of carbon. The President, he said, only appeared to recognise a single critical point at which heat is evolved, and to that he always applied the name of "Recalescence." Osmond has, however, shown that there are at least two perfectly distinct phenomena which may be observed in cooling masses of iron. First, there was the transformation of hard iron into soft iron; and secondly, the "Recalescence of Barrett." Heat is

evolved at both points, but the first is variable in position, according to the chemical composition of the mass, and is that at which the magnetism reappears. The second point, the true recalescence, occurs at a fairly constant temperature of about 640° C., and it has, Prof. Austen considered, no appreciable effect on the magnetic properties of the mass, but is essentially due to a change in the relations between the carbon and the iron. Referring to Dr. Hopkinson's remarks on the "double recalescence of soft steel," he said that the two distinct evolutions of heat were due to totally different causes, and not to any want of uniformity in the mass. As regards the President's statement that the magnetic properties of iron "appertain to the *molecule*, and not to the *atoms* of the mass," Prof. Austen asked—Is it a great step from this to admit that more than one kind of iron can exist? Normal iron may, he urged, under certain conditions, pass into an allotropic form in which the arrangement of the atoms in the molecule is different from that of ordinary iron, and the physical properties of these two kinds of iron are as totally distinct as those of the allotropic modifications of sulphur and phosphorous are from those of the elements in their normal forms.

Prof. S. P. THOMPSON said the behaviour of the nickel iron alloy reminded him of a specimen of natural alloy of the same two metals shown to him some years ago by M. Becquerel. This differed in its magnetic properties from Dr. Hopkinson's samples, for although it was non-magnetic when first obtained, it became magnetic on being heated and allowed to cool. Alluding to the supposed instability of iron, as mentioned by Prof. Ewing, Dr. Thompson said that in a paper on the "Mechanism of Magnetisation" Chwolson* had arrived at some very interesting results. The experimenter endeavoured to distinguish between temporary and sub-permanent magnetism, and his curves show that the former increases regularly at first, and afterwards more slowly, whilst the latter makes a sudden rise when the magnetising force reaches a certain value, and afterwards remains nearly constant as the force increases. The sums of the two effects gives the usual magnetisation curve (see fig. B). Referring to the question of




T total; *t*, temporary; S, sub-permanent.

FIG. B.

"permeability," Dr. Thompson described a simple apparatus for measuring that quantity which he had recently devised for workshop purposes. This consists of a slab of good iron, having a rectangular hole through it. One end of the hole is truly surfaced, and at the other end a hole is drilled in the slab parallel to the length of the rectangle; through this hole the rod to be tested is inserted, and its faced end rests on the plane surface at the bottom of the rectangular hole. A current is then sent through a solenoid, surrounding the test rod, and the force required to detach the rod from the surface end is measured by a spring balance. The permeability is then calculated from the formula

$$\mu = \frac{1317}{H}\sqrt{\frac{P}{A}}$$

where H is the magnetising force used, P the force of detachment in lbs., and A the area of the rod end in square inches.

Prof. AYRTON asked Dr. Thompson whether the character of the surfaces in contact affected the results obtained by his new apparatus. He also said the curves for temporary and sub-permanent magnetism referred to by the same speaker were very interesting, and had a practical significance in the construction of electrical measuring instruments in which soft iron is used. Speaking of the magnetic properties of iron at high temperatures he enquired whether the President had tried if these properties were regained at a white heat, for he remembered reading in a pamphlet by Dr. Wormwell that such was the case. On roughly trying the experiment by heating a piece of iron in a blowpipe flame and bringing a magnet near it, he had only found one out of three pieces to give any signs of magnetisation, and of this he was not quite certain. Another question on which he desired information was an apparent anomaly in the magnetisation of two iron rings, which he had constructed some years ago from the same bar and annealed together. One ring is continuous whilst the other is divided at one point by a narrow slit. On determining their magnetisation curves, the induction in the divided ring is found to be considerably below that in the whole one for low values of the magnetising force, but for large forces the induction in the cut ring is decidedly greater than in the uncut one. Another curious effect with the same rings and which has hitherto remained unexplained is that the deflection of the ballistic galvanometer caused by changing the magnetising current from + A (ampères) to − A is different from that produced by changing it from − A to + A, and this difference remains however many times the reversals are made.

Mr. SWINBURNE, alluding to Weber's "Theory of Magnetisation," enquired if any experiments had been made with the object of setting the axes of all the magnetic molecules parallel, and thus reducing the angle of the cone within which, for a given magnetising force, they must all lie. As a method of doing this he suggested that a wire be subjected to longitudinal and circular magnetisation simultaneously. Referring to the terminology of the subject he said the word "magnetisation" generally conveyed very vague ideas to the average mind, and thought its use should be avoided.

Mr. PREECE described the methods of testing magnet steel used by the Post Office authorities, and promised to add a table of tests to his remarks as printed in the Journal. The tests are made by two methods, 1st by determining the force required to detach an armature, and, 2nd, by the magnetometer method. A great improvement, he said, was made in the magnetic quality of steel by the addition of about 3 per cent. of tungsten, the influence of which was brought into prominent notice by the Alverre steel exhibited at the Paris Exhibition in 1881. Speaking from the records of the Post Office tests he was sorry to say that the quality of magnet steel is seriously deteriorating, for in 1883 steel giving a permanent induction of over 5,000 C.G.S. units was obtainable, whereas in 1886 this had fallen to 3,700. Recent tests show a still further deterioration, for one specimen gave 2,320; another, 1,948; and a third, 1,411. The subject, he thought, required the careful attention of manufacturers, and he hoped that immediate steps would be taken to improve the quality of magnet steel. On examining the numbers obtained by Continental observers, he found that the maximum value had been obtained by Kohlrausch, and was 3,900. Mr. Preece also directed attention to an article by Prof. Trowbridge in the current number of the *Phil. Mag.*, which gives particulars of an alloy of nickel and tungsten. This alloy is capable of retaining a higher degree of permanent magnetism than ordinary tool steel, for the maximum induction amounts to 1,033, whereas that for nickel alone is only 120.

Mr. EVERSHED confirmed Mr. Preece's remarks on the deteriorating quality of magnet steel, and said that in testing magnets he found it very convenient to use a test coil and galvanometer. Referring to nomenclature, Mr. Evershed said he was one of those who thought there was no need to use the word magnetisation in its present ambiguous sense, and that the ideas of polarity, magnetic moment, free magnetism, &c., were not required, except (perhaps) for permanent magnets; even with them, now that the President has given a definite meaning to "coercive force," this value of H, together with the permeability, seemed to him to give all the necessary information. He also thought the word "induction" should be defined to mean what is generally called "total induction," and a new name should be given to density of induction, or induction per unit area. For some time past he and his colleague, Mr. Vignoles, have been in the habit of using the word "Thomson" to denote a line of force, but they would be quite willing to adopt any other name which would meet with general approval. Quite recently he had been engaged with Mr. Vignoles in investigating the properties of iron when subjected to magnetic cycles such as occur in transformers, and had found it a great convenience to wind the transformer with two primaries. In one of these a constant current is maintained, and the whole cycle is obtained without reversing the testing current in the other coil. Speaking of the instability referred to by Prof. Ewing, Mr. Evershed said their results gave no indication whatever of such a phenomenon, and as to the effect of vibration they had found that a good blow with a hammer only produced a change of about 2 per cent. at the most sensitive part of the curve. Prof. Ewing's results, he ventured to think, might be due to want of endlessness in the specimens tested.

Some discussion took place between Profs. AYRTON, THOMPSON, and PERRY, and Messrs. EVERSHED and VIGNOLES as to whether there was any advantage in having two primaries on the transformer used in the experiments on magnetic cycles, but no very clear understanding was arrived at, excepting that the latter gentleman considered it much more convenient to change the magnitude of a current than to reverse it.

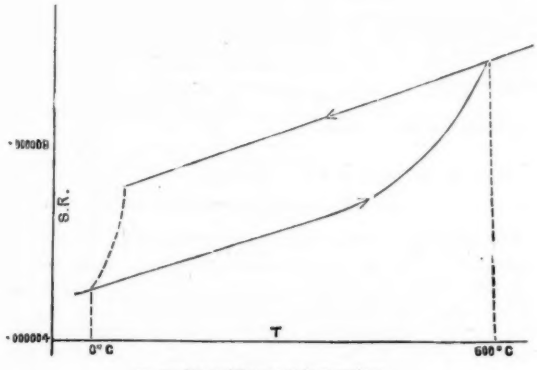
Mr. A. P. TROTTER asked the President whether the sample of nickel iron alloy, whose properties were represented in fig. 11, was unique, or whether other alloys have been found to give similar results. The remarkable peculiarities of this specimen suggests the possibility of copper, lead, &c., being cooled low enough to become more negative than Mr. Preece's magnet steel.

The PRESIDENT, in replying to Sir W. Thomson's remarks on recalescence, said that in heating the metal, a considerable absorbtion of heat occurs at about 30° C. above the temperature at which recalescence takes place on cooling, but his experiments proved that the changes in the magnetic properties follow precisely the absorbtion and liberation of heat both in ascending and descending.

Referring to Prof. Ewing's remarks on what he called the "hysteresis of nickel steel," shown in fig. 11, Dr. HOPKINSON said he thought the word hysteresis not very appropriate when applied to this phenomenon, for he considered the peculiarity more analogous to change of state from liquid to gas or *vice versa*, as in

* *Poff. Ann.* (Ergänzuntand), VII., p. 535.

the case of water, for example, these changes can be considerably retarded by adopting suitable precautions. Prof. Roberts-Austen had, be said, alluded to the liberation of heat when iron changed from the non-magnetic to the magnetic state; the phenomena accompanying this change seemed to him (the President) to be analogous to "boiling with bubbling," where the temperature of the liquid is first raised considerably above the boiling point and a sudden liberation of vapour brings down the temperature. As regards Prof. Ayrton's question relating to the return of the magnetic property at high temperatures, he could only say that he had not observed it, but the greatest temperature attained in his experiments was about 950° C. To experiment at higher temperatures was a very difficult matter, for copper is then near its fusing point, and platinum cannot be used, because at this temperature it decomposes the silica of the asbestos used to insulate the magnetising and test coils. He could not offer any explanation of the observations on the iron rings described by Prof. Ayrton, and for the present must regard them as anomalous. Referring to the revision of terminology, suggested by several speakers, Dr. Hopkinson thought there was no necessity for this, for the terms "poles," "magnet moment," &c., were most convenient when talking of permanent magnets, whilst "induction" and "permeability" were preferable when the magnetisation of iron was under discussion. In reply to Mr. Trotter, he said that many other alloys had been tried, and one specimen of nickel steel containing 5 per cent. of nickel gave very similar results to that shown in fig. 11, but the range between the critical temperatures was considerably shorter, these temperatures being 650° C. and 800° C. respectively. The same sample tested for recalescence was found to absorb heat about 800° C., and, on cooling, heat was liberated about 650°, thus showing the close connection between these phenomena and magnetisability. Since last meeting he had tested the variation of specific resistance of nickel steel with temperature, and found that a considerable reduction was produced by cooling it in solid carbonic acid. On heating, its resistance increased slowly and uniformly at first, and afterwards with increasing velocity until a temperature of 600 degrees was reached. At this temperature a sudden change occurred, and the resistance increased more slowly and uniformly as the temperature rose; on cooling the specimen its resistance fell uniformly until at the ordinary temperature it returned to its initial value. The whole cycle could be repeated by again cooling in carbonic acid, and proceeding as




SR, specific resistance; T, temperature.

FIG. C.

before. Fig. C shows diagrammatically the character of the change. Other samples were tested for tensile strength, and when in the ordinary state gave an average breaking stress of 50 tons per square inch with an extension of 30 per cent.; specimens which had been chilled broke at 85 tons with an extension of only 8 per cent. This fact, he said, was of vast importance from an engineering point of view, for if such changes in the nature of a mild steel were brought about by its being subjected to a hard frost, the consequences would be very serious if such a metal were used in structures.

## Civil and Mechanical Engineers.

ON Wednesday, January 22nd, an ordinary meeting of the Civil and Mechanical Engineers' Society, the President, Mr. HENRY ADAMS, in the chair, was held at the Westminster Palace Hotel, when a paper, entitled "The Present Aspect of Electric Lighting in London," was read by Mr. E. C. DE SEGUNDO.

The author held the fact that so many well-known commercial and professional men had connected themselves with companies, as a proof that electric lighting had now passed the experimental stage and was fairly on the way to assured success.

He referred briefly to the various schemes on foot for the supply of electrical energy, but only considered two systems in any detail, that adopted by the London Electric Supply Corporation and that by the Metropolitan Electric Supply Company.

He pointed out that the former laid themselves open to be accused of putting all their eggs in one basket, and suggested that the use of engines of so large a horse-power might tell a great deal against the alleged economy of the whole system, inasmuch as, to run an engine light is—as is well known—very uneconomical.

There was also this further disadvantage, that should a bearing of the 10,000 horse engine or dynamo heat badly, about 200,000 lights, or their equivalent, would be extinguished by the stoppage of the engine.

The undeniable advantages of such a station were dwelt upon, namely the possibility of using cheaper coal, not having to pay for water or rent, and being able to condense. It appears to be further claimed by the Electric Supply Corporation, that considerable economy will be effected in the expense of the necessary staff over the multiple generating unit system; but this the author does not seem to consider of much importance when taken in conjunction with other questions, such as the loss in the six miles of mains from Deptford to London, and that due also to the extra transformation.

He next spoke of the Metropolitan Electric Supply Company, and described how their supply of electrical energy was produced by a large number of small generating units distributed in groups over the area of supply, all the groups being connected by trunk mains. This company claims that by having their works on the spot, any diminution in the supply due to sudden changes of the weather from clear to foggy, can more easily be provided against than if the generating station were at a distance, and that immunity from failure of supply is effectually secured inasmuch as the breakdown of a single engine or dynamo would not be noticed by the consumer; and even if a complete station were to break down, the spare power of two or more of the remaining stations could be requisitioned to supply the deficiency thus created. There was further the advantage of only one transformation and lower pressure in the supply main, as against two transformations in the London Electric Supply Company's system, and a very high pressure in the primary mains. It was further worthy of remark, the author continued, that the Metropolitan Company were building stations containing machinery of a type which involved no experimental element, and which combined the latest improvements, as against the London Electric Supply Corporation, whose system could hardly have been said to have passed the experimental stage; and that, further, although the Metropolitan Company can only be said to have commenced active operations in September last, they are now supplying upwards of 15,000 lights (8 C.P.), and are under contract to supply 31,000 more, which are installed and waiting for the current, the necessary energy for which will be available by next March.

He then referred briefly to the vexed question of underground *versus* overhead mains, and after a few other remarks on matters of general interest connected with the subject, he concluded by stating that it was justifiable to assume that at present there was a "boom" in alternate current machinery, and he would not be surprised to see supply companies revert to the high tension continuous-current transformer system, inasmuch as it was probable that no great difficulty would be experienced in making the efficiency of the continuous-current transformer system compare very favourably with the mean efficiency of the alternate-current transformer system.

## ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1888.

18035A. "An improved ampère gauge and connections." SIR WILLIAM THOMSON. Dated, December 11. 11d. For an inspectional ampère gauge the current to be measured is so dealt with in a vertical solenoid, that it pulls in one direction, preferably upwards, a thin bar or needle of soft iron hanging vertically from a spring or from one arm of a counterpoised balance. The amount of the current is indicated by an index upon a scale. This index is deflected through angles varying according to the extent to which the needle is attracted into the solenoid. A solenoid of any known construction may be used. The solenoid which is preferred is of special construction consisting of a series of flat plates divided and bent at the centre, and united so as to form a solenoid. A current through this solenoid produces a strong magnetic force in its hollow interior field of which the transverse section is of small diameter and may be of circular or elongated shape. The improvements also include a spring clip for throwing any part of the apparatus into or out of the circuit in which it is to be used without disturbing other apparatus in the circuit. The improved clip consists of an arrangement by which two conductors, both of which may be elastic, preferably a number of elastic plates, or one elastic and one rigid, meet at an angle which may be acute or obtuse or zero, and are pressed by screw or otherwise elastically but firmly against each other. The constituent parts of the elastic portion of the clip may be insulated from each other and connected through resistances to a single conductor when it is desired to gradually introduce resistance before breaking the circuit. The circuit is broken or extended by a plate-piece which consists either of a flat piece of slate or other insulating material, or of a couple of flat pieces of metal each connected to a flexible electrode but insulated from one another by slate or other insulated material and firmly bolted together. The first mentioned plate-piece is used to break the circuit, the second to extend the circuit by inserting another circuit. 5 claims.

18137. "Improvements in simple and compound switches for electrical currents." W. HARTNELL. Dated December 12. 11d. Has reference to an improved mode of building up and working simple and compound switches, generally similar to those referred to in the inventor's former patent on this subject, No. 6487, A.D. 1886. 21 claims.

18319. "Improvements in or relating to suspenders for shades, reflectors, or lamps, especially applicable to electric lamps." W. S. BOULT. Dated December 15. 8d. In addition to or in substitution for the ordinary central grip of the lamp holder, the shade is suspended by a series of cords or equivalent attached either to it or to projecting arms on the shade carrier at points some distance from and disposed round the centre, preferably in a plane parallel to the base of the shade and passing through the centre of gravity of the suspended and movable load. Each of the suspending cords referred to passes through an eye or equivalent on the central cord by which the whole apparatus is held, and has its ends fastened to opposite points on the shade or shade carrier, as explained. 6 claims.

18505. "Improvements in electrical torches for lighting gas." H. B. SHERIDAN. (Communicated from abroad by J. D. Culp, of America.) Dated December 18. 8d. Claims:—1. An electrical torch for lighting gas, consisting of a disc of vulcanite gum having metal on its under side, of a second disc of vulcanite gum having metal foil on its under surface, and arranged to be forced against the said first disc by a spring, so as also to make electric connection between the said two metals, and to be withdrawn therefrom by pressure applied through the hand and of a tube connected to one metal foil, and carrying within it an insulated wire connected to the other foil, the said wire being bared at its end, which is adjacent to the end of an adjusting screw fitted in the end of the said tube, holes being provided at this part of the tube for the passage of the gas, the said tube also forming the support for the different parts and the handle of the torch, substantially as described. 2. The arrangement and construction of an electrical torch for lighting gas, substantially as described with reference to the drawings.

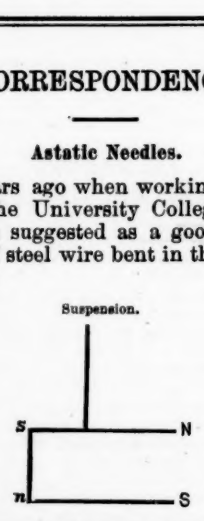
18784. "Method of and means for regulating electric currents, dynamos machines, and electromotors." W. F. LAHMEYER. Dated December 22. 11d. Chiefly consists in replacing the variable resistances, hitherto employed for the regulation of currents, by the counter electromotive force produced by a freely revolving armature introduced into, or otherwise connected with the (magnetic) circuit. 7 claims.

18858. "Improvements in electro-chemical generators." F. J. BROUGHAM. (Communicated from abroad by La Société Perreur-Lloyd and Fils, of Paris.) Dated December 24. 8d. Relates to electro-chemical generators, capable of producing metallic salts on a commercial scale, whilst permitting of the utilisation of the electric current produced. 10 claims.

## CORRESPONDENCE.

### Astatic Needles.

Some five years ago when working in the Physical Laboratory of the University College, Bristol, Prof. S. P. Thompson suggested as a good form of astatic needle a piece of steel wire bent in the shape of a rectangular V, thus




There are several advantages belonging to this form, the most important of which is, that it is necessarily more easy to obtain the astatic condition; in fact, if the parallel sides of the V are of the same size in length and diameter and the same temper, and the whole is uniformly magnetised, such *must* be its condition. In this way the endless trouble of getting the two needles of equal power is got rid of. Another reason is, that a very serviceable astatic needle of this form can be easily and quickly made from a piece of stout "piano wire," the temper of which is usually very fairly uniform.

I adapted one of these needles to an ordinary lecture room astatic galvanometer with success, and also to an ordinary "detector," in which the improvement was very marked. From this experience I suggested to Dr. S. P. Thompson that a needle of this form could be used with like advantage in his lantern-slide galvanometer.

This needle very much resembles the one described in last week's ELECTRICAL REVIEW, but I think the form of needle I have described is better, usually that is, than Mr. Wynne's, on account of the ease of getting astaticity and also of retaining it. I said just now, "usually," because there are cases in which Mr. Wynne's form could be, and the form I have described could not be, used. I fail to see, however, the benefit of using three magnets as suggested by Mr. Wynne, as the advantage in increased sensitiveness due to the lower needle, would be more than counterbalanced by the loss of astaticity.

**A. T. Bartlett.**

*January 25th*, 1890.

### A Suggestion.

Referring to your remarks in last issue of REVIEW, you are quite right, Sir, but I purposely avoided touching upon the manhole until another occasion, and you will observe that the recent plans simply show the conduit.

The ventilation of the manhole would be carried out on a similar principle, but with a larger pipe.

Yes. I lost sight of the REVIEW for December 27th last, otherwise I might, or should, have referred to this earlier production of conduit. I shall be very pleased indeed, Sir, to see these suggestions criticised (they were submitted with this object) by you or by those engineers who have gone through the mill, so that we may speedily arrive at a universal system of conduit and manhole for electric lighting, and thus, if electricity is to supersede gas, benefit mankind. A manhole 4 feet square and 8 feet deep inside should answer most requirements.

**One Interested.**

*January 27th*, 1890.

### Electrical Engineers.

In reference to your excellent little sermon to young aspirants to the electrical engineering in your issue of the 3rd inst., for which I, for one, am much obliged, may I ask your further kind advice as to how I could best carry out your strongly urged suggestion about "getting into harness at once?" The study of your article has created in me a strong desire for doing this without delay, which I would have done had I only known how.

The following is a brief synopsis of the facts of my case:—Am 24 years of age, and fairly well educated. Having lost father and mother was obliged to leave college when 19 and accept a clerkship for a living, *pro tem.* Am at present a shorthand correspondent in a large West End drapery establishment, devoting the whole of the little spare time at my disposal to the study of electricity and magnetism, sound, light and heat, and higher mathematics, in the Polytechnic evening classes, my natural bent being for engineering, the electrical branch of which I have chosen for my future career, to excel in. Am strong, healthy, and not afraid of hard work—muscular or otherwise—having been brought up on a Welsh farm. Have had no experience in engineering, and cannot afford to pay a premium. Should like out-door employment, such as constructing a bridge, or an underground railway, or opening up mains for the laying of cables, &c. For the sake of a start should only require very moderate wages. Is my case a hopeless one, and, if not, how should I proceed?

Hoping you will pardon my presumption, and thanking you in anticipation.

**An Earnest One.**

January 27*th*, 1890.